BUILDING CODE

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CITY OF BOSTON

BUILDING CODE

OF THE

CITY OF BOSTON

Consisting of Chapter 479 of the Acts of 1938, As Amended by Chapter 217 of the Acts of 1939, With the Amendments by Ordinance Incorporated.

CITY OF BOSTON
ADMINISTRATIVE SERVICES DEPARTMENT
PRINTING SECTION
1964

CITY OF BOSTON,

OFFICE OF THE CITY CLERK.

August 15, 1964.

I hereby certify that Chapter 479 of the Acts of 1938, as amended by Chapter 217 of the Acts of 1939, was accepted by order passed by the City Council on May 10, 1943, and approved by the Mayor on May 15, 1943.

I hereby further certify that pages 5 to 284, inclusive, of this volume contain a true copy of Chapter 479 of the Acts of 1938 as amended by Chapter 217 of the Acts of 1939 and by ordinances of the City of Boston adopted in the period from May 15, 1943, to date.

Attest:

J. M. DUNLEA,
City Clerk.

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The Commonwealth of Massachusetts

ACTS OF 1938, CHAPTER 479

AN ACT FOR CODIFICATION, REVISION AND AMENDMENT OF THE LAWS RELATIVE TO THE CONSTRUCTION, ALTERATION AND MAINTENANCE OF BUILDINGS AND OTHER STRUCTURES IN THE CITY OF BOSTON.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

PART I.

ADMINISTRATION.

Section 101. Title.— This act shall be known and may be cited as the Boston Building Code and is hereinafter referred to as this code.

Sect. 102. Repeals.— Except as provided in section one hundred and three, the following acts and parts of acts, as severally amended, are hereby repealed; — chapter two hundred and sixty-five of the acts of eighteen hundred and ninety-seven; the two paragraphs added to section four of chapter three hundred and eighty-three of the acts of nineteen hundred and five by section one of chapter one hundred and fifty-six of the Special Acts of nineteen hundred and nineteen; chapter five hundred and fifty of the acts of nineteen hundred and seven, except section one hundred and twenty-eight thereof; chapter three hundred and forty-two of the acts of nineteen hundred and eleven; chapter seven hundred and twenty-nine of the acts of nineteen hundred and thirteen; chapter seven hundred and eighty-two of the acts of nineteen hundred and fourteen; sections one to five, inclusive, of chapter one hundred and sixty-three of the Special Acts of nineteen hundred and nineteen; chapter two hundred and seventy-eight of the acts of nineteen hundred and twenty-three; chapter one hundred and eighty-two of the acts of nineteen hundred and twenty-six; and chapter forty-two of the acts of nineteen hundred and twenty-seven.

Sect. 103. Pending Actions.— All actions and proceedings, at law or in equity, and all prosecutions, pending on the effective date of this code, whether commenced for the purpose of enforcing any of the provisions of the acts, or parts thereof, repealed by the preceding section or brought upon any complaint or indictment for the violation of any of such provisions, or for the violation of any ordinance, rule or regulation established thereunder for the violation of which a penalty of a fine or imprisonment, or otherwise, is provided therein, may be prosecuted and enforced to the same extent as if said acts, or parts thereof, were still in force and effect.

Sect. 104. Other Statutes.— All statutes applicable generally to departments of the city of Boston, including the provisions of section five of chapter four hundred and eighty-six of the acts of nineteen hundred and nine, as most recently amended by chapter two hundred and twenty-seven of the acts of nineteen hundred and thirty-four, and any pertinent action taken thereunder whether before or after the effective date of this code, shall apply to the building department and to the boards established under sections one hundred and nine, one hundred and seventeen, one hundred and twenty and one hundred and twenty-one hereof.

***Sect. 105. Effective Date.**— This code shall take full effect upon its acceptance by vote of the city council of the city of Boston, subject to the

provisions of its charter. If an application for a permit is filed before said effective date, and a permit is issued thereon and the work is actually commenced within ninety days after the issuance of the permit, the applicant notwithstanding any provision to the contrary in section one hundred and seven, may elect to be governed in the entire operation covered by the permit either by the building laws as they existed when the application was filed or by this code.

[**As amended by Ord. 1943, ch. 2*]

†**Sect. 105A. [Amendment by Ordinance.]** — The city of Boston, for the purposes of the prevention of fire and the preservation of life, health and morals, or for any of such purposes, may from time to time, by ordinance and upon the written recommendation of the building commissioner or the board of appeal, regulate the inspection, materials, construction, alteration, repair, height, area, location and use of buildings and other structures in said city, except such buildings or structures as are excluded from the operation of this code by sub-section (a) of section one hundred and seven, and for any or all of said purposes may from time to time, by ordinance upon like written recommendation, alter, amend, extend or render ineffective any provision or provisions of this code regulating building and other structures as aforesaid.

[*†As inserted by Stat. 1939, ch. 217*]

‡**Sect. 106. Definitions.**— (a) For the purposes of this code the words and phrases defined in this section shall be construed as so defined except when the context clearly indicates that another meaning is intended.

"Abut", touch, be contiguous. A building abuts upon a street when some part of the building touches or extends to the line of the street. A building shall be construed to abut upon a street if it is nearer at any point than ten feet from the street or when the space between the building and the side line of the street is used wholly or chiefly for the purposes of a street or sidewalk.

"Apartment", a room or suite of rooms occupied by one person or one family for living and sleeping purposes.

"Apartment hotel", a building containing four or more apartments without kitchens, primarily for persons who have their residences therein.

"Apartment house", a building containing four or more apartments with kitchens, primarily for persons who have their residences therein.

"Approved", approved by the building commissioner of the city of Boston.

"Area of a building", see "Building, area of".

"Assembly hall", a hall or room, including the balconies thereof, if any, in which persons may assemble in a manner as permitted in Group B, Part 4.

"Attic", finished or unfinished story situated within a sloping roof, the area of which at a height of four feet (4) above the level of its finished floor does not exceed two-thirds (2/3) of the area of the story immediately below it. There shall be only one attic in any building, and it shall be considered as a half story.

"Auditorium", an assembly hall in which persons may assemble to hear or see concerts, plays, lectures, athletic or sports events or similar performances.

"Automatic sprinklers", a system of piping supplied with water under pressure with devices for releasing under the influence of heat and spraying the water on ceilings, walls and floors.

"Balcony", within an auditorium, is a floor, inclined, stepped, or level, above the main floor, the open side or sides of which shall be protected by a rail or railings. Where a balcony of an auditorium has exits at two or more levels opening into separate foyers, one above another, each portion thereof served by such a foyer shall be considered a separate balcony for the purpose of this code.

"Basement", a story of a building below the first story.

"Building", a structure forming a shelter for persons, animals or property, and having a roof The word "building" shall be construed, where the context allows, as though followed by the words "or part thereof." The word "building" shall not include such frame-works and tents as are customarily used exclusively for outdoor carnivals, lawn parties or like activities.

"Building, area of", the maximum horizontal projected area of a building, above ground, within the property lines, including exterior walls one or more of which may be party walls and including covered porches but excluding terraces, steps and cornices.

"Building, height of", in linear measure, the vertical distance of the highest point of the roof, excluding pent houses and roof structures, above the mean grade of the sidewalk at the line of the street or streets on which the building abuts; and, if the building does not abut on a street, above the mean grade of the ground around and contiguous to the building; and provided, further, that for the purposes of establishing said mean grade, the ground bounded by the lot lines and contiguous to the building and within twenty feet of it, shall be considered to slant toward the building not more than one foot upward or downward in two horizontal feet. In stories, the number of stories above the floor of the first story.

"Building, pre-code", a building already erected on the effective date of this code, or thereafter erected, as provided in section one hundred and five, under permit for its construction subject to the provisions of law in effect prior to such effective date.

"Building, post-code", a building erected after the effective date of this code and subject to the provisions thereof.

"Bulkhead", the raised portion of a floor or roof, raised for the passage of persons, materials, light or air, through the side of such raised portion, or for other purpose.

"Cellar", see basement.

"Chimney", a vertical structure of masonry with one or more flues in which smoke or the products of combustion are conducted upward for disposal in the open air at a height above the ground.

"Code", "this code", the Boston Building Code, consisting of this act and the regulations established thereunder.

"Commissioner", the building commissioner of the city of Boston.

"Corridor", an enclosed passageway.

"Dead load", the weight of materials built into the construction of a

building including walls, permanent partitions, floors, roofs, framing and all other permanent stationary construction entering into and becoming part of a building.

"Department", the building department of the city of Boston.

"Exit", a means of egress; a way out.

"Exit from a room", a doorway or other means of egress from the room on the way toward an exit from the building.

"Exit from a story", a stairway, ramp, ladder or other means of egress from the story on the way toward an exit from the building.

"Exit from a building", a doorway or other means of egress from the building opening upon a street or upon an open space with unobstructed access to a street.

"Exit, path of", the continuous series of doorways, connecting rooms, corridors, passages, stairways, ramps and the like, which leads from any exit from a room through an exit from the building.

"Family", a group of persons living together who share at least in part their living quarters and accommodations.

"Fire division", a portion of a building so separated from the rest by separations as specified in Part 13, that it may be erected to the maximum height and area allowed for its principal occupancy and type of construction, independently of adjoining occupancies. A portion of a building separated from the rest by fire walls. A fire division may not be larger than a maximum unit of occupancy and may be further limited by the application of requirements of Table A, (2), section thirteen hundred and two.

"Fire division, area of", the maximum horizontal projected area of the division within the property lines including exterior walls, one or more of which may be party walls, and in the case of separation walls within the property lines to the center of the separation wall.

"Fire door", a door of fire-resistive construction as described in Part 22.

"Fire extinguisher", a portable device the contents of which are for extinguishing a fire.

"First aid hose station", a hose connection with valve in a system of piping adequately supplied with water, hose and nozzle for use of occupants of a building in extinguishing a fire.

"Floor area", of a room, the area of the floor contained within the walls.

"Foundation", that portion of a building or structure of which the sole or chief purpose or use is to transmit the weight of the building or structure to the earth; the support of the lowest portions of columns, walls, piers or other vertical members.

"Foyer", a foyer, lobby, corridor or passage, one or more in combination, adjacent to the auditorium of a theatre or assembly hall at the level of the main floor or a balcony thereof and into which one or more exits therefrom open, in the path of normal egress from the building.

"Front", a building or wall fronts upon a street when a wall of the building or the wall faces the street and is parallel thereto or makes an angle of less than forty-five degrees therewith.

"Fusible link", a device consisting of two pieces of brass or other suitable metal connected by solder or other metal fusible at a moderate temperature, arranged to release in the presence of fire or excessive heat; or any equivalent approved device.

"Gage", for sheet metal, United States Standard Gage; for brass and copper tubing, Stubs Gage; for wire, Washburn & Moen or Roebling Steel wire gage.

"Garage", a building or portion thereof in which is housed or stored one or more motor vehicles containing or using a volatile flammable fluid for fuel or power, or in which such motor vehicles are painted, repaired or serviced.

"Gasfitting", the art of installing, repairing or altering pipes, fittings, fixtures and other apparatus for distributing gas for heat, light, power or other purposes; the system of pipes, fittings, fixtures and other apparatus for distributing gas for heat, light, power or other purposes.

"Grade", elevation with reference to Boston city base, namely, a horizontal plane of reference established and used by the city of Boston.

"Grade, mean", the average of the grades of mid-points of successive equal distances of not over ten feet measured along the line or lines along which the mean grade is to be determined.

"Hotel", a building containing four or more apartments without kitchens, or sleeping accommodations for ten or more persons, primarily the temporary abode of persons who have their residences elsewhere.

"Kitchen", a room used or adapted for cooking and containing a stove, range, hot-plate or other cooking apparatus, which burns coal, oil, gas or other fuel or is heated by electricity, except electric appliances consuming less than eighteen hundred watts.

"Lintel", a beam in a masonry wall supporting the masonry above an opening.

"Live load", the load or weight to be supported on floors or other portions of buildings incidental to their occupancy; the pressure of wind, the weight of snow, and all loads other than dead loads.

"Masonry", construction of assembled units of stone, brick, concrete, gypsum or other similar incombustible materials separated from one another and held in place by mortar.

"Masonry, dry", masonry, except that the units are not separated or held in place by mortar.

"May", a term giving permission but not, except in the negative, making a requirement. "May" is used in this code to emphasize that specified construction is not prohibited by the code when such prohibition might otherwise be implied or construed; or to limit the scope of a prohibition by excepting specified construction from its effect. A permission so expressed in this code in specific terms shall not be construed as a prohibition of other construction. "May not" is prohibitive.

"Mezzanine floor", a floor within a story between the floor and ceiling thereof, having an area not over forty per cent of the area of the building at the level at which the mezzanine floor occurs. A floor of larger area separates two stories.

"Non-corrodible metal", a metal which, under the conditions of its use, may reasonably be expected, without unusual or excessive maintenance, to serve its purpose throughout the probable life of the structure in which it is used as determined by the commissioner.

"Occupancy", use or occupancy of a building, character of use, or designated purpose of a building or structure or portion thereof.

"Occupancy, unit of", that portion of one building within separations within which the occupancy, whether of one or more tenants, falls in a single group and division as classified in section one hundred and thirty-two and Parts 3 to 12, inclusive, of this code.

"Or", providing an alternative at the option, unless the contrary is clearly indicated, of the applicant for a permit.

"Owner", the owner of the land as recorded in the registry of deeds for Suffolk county, or as registered in the land court, except as otherwise provided in paragraph (d) of this section.

"Partition", see Wall.

"Passageway", a continuous way, of required width, kept clear for use as an exit, whether enclosed or not.

"Pier", a vertical body of masonry used as a column, the portion of a masonry wall between thinner portions or between openings when the horizontal dimension parallel to the wall does not exceed four times the thickness.

"Plan or plans". The word plan or plans shall be construed to mean drawing or drawings illustrating the work involved.

"Plumbing", the art of installing, repairing or altering the pipes, fixtures and other apparatus for distributing the water supply and removing liquid and water-carried wastes; the system of pipes, fixtures and other apparatus installed in buildings for distributing the water supply and for the disposal of liquid and water-carried wastes, including valves, traps and soil, waste and vent pipes; provided, that nothing herein contained shall include the work of steamfitting.

"Projection room", a room in a theatre or assembly hall containing a projector of moving pictures.

"Remote", in reference to two or more exits, removed or distant from one another in such manner that a person in any place served by such exits may choose either of two directions in a path toward an exit and in such manner that a single fire could not, in its early stages, block both paths toward an exit.

"Seating capacity", the number of seats within an auditorium or other hall when fastened to the floor; the number of persons who may be seated within an auditorium or hall allowing six square feet of floor area per person unless fixed seats are provided.

"Separation", a system of walls, floors or other construction serving to separate or cut off one unit of occupancy from another.

"Shaft", an enclosure of a vertical opening in two or more stories.

"Smoke pipe", a flue, approximately horizontal, of metal or other material, in which smoke or the products of combustion are conducted from a furnace to a chimney or stack.

"Smoke stack", a vertical flue of metal or reinforced concrete, whether or not lined with masonry or other protective material, in which smoke, or the products of combusion, are conducted upward for disposal in the open air at a height above the ground.

"Soil", the softer matter mostly inorganic composing part of the surface of the earth in distinction from the firm rock; including gravel, clay, loam and the like, and filling materials of similar nature.

"Sprinklers, automatic", a system of automatic sprinklers installed in accordance with this code.

"Stair, rise of", the vertical distance between successive treads or steps measured always from the same relative position thereon.

"Stair, tread of", the horizontal distance from one riser to the next or from one nosing to the next.

"Story", that portion of a building included between the top surface of a floor and the top surface of the next floor or roof above, except that a space used exclusively for the housing of mechanical services of the building shall not be considered to be a story if access to such space may be had only for maintenance of such services.

"Story, first", the lowest story of which sixty-five per cent or more of the height is above the mean grade from which the height of the building is measured.

"Structure", a combination of materials assembled at a fixed location to give support or shelter, such as a building, bridge, trestle, tower, frame-work, retaining wall, tank, tunnel, tent, stadium, reviewing stand, platform, bin, fence, sign, flag-pole or the like. The word "structure" shall be constructed, where the context allows, as though followed by the words "or par thereof".

"Unit of occupancy", see "Occupancy, unit of".

"Unit of occupancy, area of", the maximum horizontal projected area of a unit of occupancy.

"Vertical opening", an opening in a floor or roof for giving access vertically from the story below or above for light, ventilation, the movement of persons or materials or for any other purpose.

"Wall, bearing", a wall which supports a floor, roof or other vertical load in addition to its own weight.

"Wall, curtain", an exterior, non-bearing wall more than one story high and not supported at each floor level, which is laterally stayed by masonry piers or by the frame of the building.

"Wall, enclosure", an interior wall, bearing or non-bearing, which encloses a stairway, elevator shaft or other vertical opening.

"Wall, fire", a wall separating two fire divisions of a building.

"Wall, non-bearing", a wall which supports only its own weight.

"Wall, panel", a non-bearing exterior wall not over one story high, or supported at each floor level.

"Wall, parapet", a wall or part of a wall above the roof of a building.

"Wall, partition", an interior bearing or non-bearing wall, not over one story in height the chief function of which is to separate two rooms.

"Wall, party", a wall used or adapted for use in common as a part of two buildings.

"Wall, retaining", a wall used to resist the lateral displacement of liquid, granular or other materials.

(b) In conformity with the purposes of this code, to prescribe the minimum requirements for structures and the maximum utility of structures consonant with safety, the phrases "at least", "not less than" or "not more than" shall be construed to precede quantitative specifications, as determined by the commissioner.

(c) Wherever in this code a public official is referred to by the title of his office without mention of any municipality, unless the context otherwise requires, such reference shall be to an official of the city of Boston.

(d) Nothing in this code shall be held to prevent the owner of land from transferring to another his rights and responsibilities under this code by means of a lease or other suitable agreement. The commissioner may recognize the person to whom such a transfer by operation of law or otherwise has been made as the possessor of such rights and responsibilities and to such extent as the owner in receiving applications, issuing permits and otherwise in enforcing this code.

[‡*As amended by Ord. 1943, ch. 2 and Ord. 1945, ch. 6*]

***Sect. 107. Scope.**— (a) The provisions of this code shall apply to every building or structure hereafter erected in the city of Boston, except public highway, railroad or railway bridges or trestles, quays or wharves, buildings owned and occupied by the United States or the commonwealth, railroad structures and stations used primarily for railroad purposes, subway and elevated railway structures and stations used primarily for railway purposes, voting booths erected and maintained by the board of election commissioners, prefabricated metal tanks of less than five thousand gallons capacity and tanks exceeding ten thousand gallons capacity for liquids other than water, tunnels constructed and maintained by a public authority, tents covering an area less than one hundred square feet, fences less than six feet high, signs or billboards upon the ground and signs less than one square foot in area, upon or attached to the outside of a structure and flagpoles less than twenty feet in length.

(b) The provisions of sections one hundred and eight, one hundred and fourteen, one hundred and sixteen, one hundred and eighteen, one hundred and nineteen, one hundred and twenty-two, and one hundred and twenty-three shall apply to pre-code buildings.

(c) A pre-code building may be altered, repaired, enlarged, moved, or converted to other uses, only in conformity with the following provisions of this section and subject to permit as hereinafter provided.

(d) A pre-code building which is altered or repaired within any period of twelve months, said alterations or repairs costing in excess of fifty per cent of its physical value, shall be made to conform to the requirements of this code for post-code buildings. A pre-code building damaged by fire or otherwise in excess of fifty per cent of its physical value before such damage shall be made to conform to such requirements, if repaired. If the cost of such alterations or repairs or the amount of such damage is more than twenty-five but not more than fifty per cent of the physical value of the building it shall

be made to conform to such requirements in the portions so altered or repaired to such extent as the commissioner may determine. For the purposes of this paragraph physical value shall mean the reproduction cost of the building less physical deterioration as determined by the building commissioner.

(e) When occupancy of a pre-code building, or portions thereof separated from the remainder as required in Part 13, is so changed that the hazard is increased, the commissioner may require that said pre-code building or said portions thereof be made to conform with the provisions of this code, which will specifically eliminate said increased hazard.

1. All buildings altered or repaired shall, in the opinion of the building commissioner, provide structural safety, adequate resistance to the spread of fire, and safe egress in the event of fire to the occupants.

2. Structural safety shall be construed to mean that a building or parts thereof shall sustain twice the loads and stresses subjected therein or thereupon by actual normal use. Owners, if directed to do so by the building commissioner, shall demonstrate such structural safety by actual load tests made as directed by him.

3. Adequate resistance to the spread of fire shall be construed to mean protection to adjacent properties and protection to egress enclosures keeping them free from fire long enough to permit the occupants to evacuate the building. The resistance of various materials and constructions to fire shall be assumed to be as stated in this code or as otherwise satisfactorily demonstrated to the commissioner.

4. Safe egresses not less than two in number shall be construed to mean egress facilities sufficient to evacuate the building in three minutes. Owners of buildings shall, if directed by the building commissioner, demonstrate the time required to evacuate the occupants by actual test conducted under the direction of the commissioner.

5. An electrical fire alarm system shall be installed, if it is necessary in the opinion of the commissioner to meet the above egress requirements.

(f) A pre-code building which is enlarged in floor area or in number of stories shall be made to conform throughout the entire building to the requirements of this code in respect to egress and fire protection.

(g) A pre-code building to which repairs and alterations are made which are not covered by the preceding paragraphs of this section, may be repaired or altered with the same kind of materials as those of which the building is constructed, providing such alterations or repairs will not increase an existing non-conformity or hazard; but not more than twenty-five per cent of the roof covering of a building shall be replaced in any period of twelve months unless the entire roof covering is made to conform with the requirements of this code for post-code buildings. New roofing meeting the requirements of this code may be placed over existing roofing providing that it be properly supported and securely fastened.

(h) A pre-code building when moved to another location shall conform to the requirements of this code relative to the fire limits, to location on the lot and to exterior walls.

(i) Except as otherwise provided in this section, no provision of this code shall be held to deprive the health department, the police commissioner,

the board of street commissioners, the licensing board, the fire commissioner or the park department of the city of Boston either of any power or authority which it, he or they had on the effective date of this act or of any remedy then existing for the enforcement of its, his or their orders.

(j) Provisions of this code relating to buildings shall also apply to structures other than buildings to such extent as they are pertinent.

[**As amended by Ord. 1943, ch. 2*]

†**Sect. 108. Maintenance.**— All buildings or structures, and all parts thereof, shall be maintained in a safe condition. All devices or safeguards which are required by this code in a building when erected, altered or repaired, shall be maintained in good working order, except as otherwise provided in section twenty-seven A of chapter one hundred and forty-eight of the General Laws. Except as otherwise provided in paragraph (d) of section one hundred and six, the owner shall be responsible for the maintenance of all buildings and structures. This section shall apply to pre-code as well as to post-code buildings.

[*†As amended by Ord. 1943, ch. 2*]

Sect. 109. Organization.— (a) There is hereby established in the city of Boston a department to be called the building department, which shall be in charge of the building commissioner.

(b) The commissioner shall have had at least ten years' experience as an architect, builder or civil engineer, and shall be appointed by the mayor for a term of five years. He shall receive such salary as shall be fixed by the city council, with the approval of the mayor.

(c) Upon the effective date of this code the building commissioner of the building department, as constituted immediately prior thereto, shall become the building commissioner of the building department established by paragraph (a) of this section, the members of the board of appeal, as constituted immediately prior thereto, shall become the members of the board of appeal established by paragraph (a) of section one hundred and seventeen, the members of the board of examiners, as constituted immediately prior thereto, shall become the members of the board of examiners established by paragraph (a) of section one hundred and twenty, and the licensed master gasfitter member of the board of examiners of gasfitters, as constituted immediately prior thereto, shall become the licensed master gasfitter member of the board of examiners of gasfitters established by paragraph (a) of section one hundred and twenty-one, and each of said persons shall thereafter hold his respective position until the expiration of such period of time as shall be equal to the remainder of the term for which he was appointed, unless sooner removed or discharged according to law; and all of the employees of the building department, as constituted immediately prior thereto, who are subject to the civil service laws shall be reappointed to similar positions in the building department or the several boards established by this code with the same status and compensation held and received by them, respectively, immediately prior thereto in the building department and the several boards established by this code, without civil service examination or registration; and the said building commissioner, and all such employees upon such re-

appointment, shall retain all rights to retirement with pension that shall have accrued or would thereafter accrue to them, and their services shall be deemed to have been continuous to the same extent as if this code had not been passed.

(d) The commissioner, with the approval of the mayor, may appoint such number of officers, inspectors, assistants and other employees as the city council shall from time to time determine. No person shall be appointed as inspector of construction who has not had at least five years' experience as a builder, civil engineer or architect, or as a superintendent, foreman or competent mechanic in charge of construction.

(e) The commissioner may appoint as his deputy an officer or other employee in the department who shall, during the absence or disability of the commissioner, exercise all the powers of the commissioner.

(f) No officer or employee connected with the department, except one whose only connection is as a member of a board, shall be financially interested in furnishing of labor, material or appliances for the construction, alteration or maintenance of a building, or in the making of plans or of specifications therefor, unless he is the owner of such building. No such officer or employee shall engage in any work which is inconsistent with his duties or with the interests of the department. The provisions of this paragraph shall not apply to the members of boards established by this code.

(g) The commissioner shall keep a record of the business of the department. The records of the department shall be open to public inspection. The commissioner shall not, however, be required to allow inspection of the plans of buildings except upon request of the owner. If such request is made more than two months after completion of the work described in the plans, the commissioner shall allow such inspection only upon payment of such fee as the commissioner, with the approval of the mayor, may establish.

***Sect. 110. Application for Permit.** — (a) Whoever desires in the city of Boston to erect, enlarge, alter, substantially repair, move, demolish or change the occupancy of a building or structure, or to install, alter or substantially repair plumbing, gasfitting, fire extinguishing apparatus or elevators, or to install a steam boiler, furnace, heater, or other heat producing apparatus the installation of which is regulated by this code, or to install an engine or dynamo, or to cause any such work to be done, shall first make application to the building commissioner and obtain a permit therefor.

No engine, dynamo, boiler or furnace shall be placed in any building without a permit from the commissioner. Every application for such permit shall be in writing, shall be filed with the commissioner and shall set forth the character of the building, the size, power and purpose of the apparatus, and such other information as the commissioner may require. The commissioner may, after an examination of the premises described in the application, and after hearing the applicant and any objectors, issue a permit for placing a boiler or furnace on such premises, upon such conditions as he shall prescribe, or he may refuse such permit. If the application is for anything other than a boiler or furnace, the applicant shall publish in at least two daily newspapers published in the city of Boston, and on at least

three days in each, and, if so directed by the commissioner, shall also post conspicuously on the premises a copy of the application, and shall deliver copies thereof to such persons as the commissioner may designate.

If no objection is filed with the commissioner before the expiration of ten days after the time of the first publication of notice, or within ten days of the delivery and first posting of the notice, if such delivery or posting is required, the commissioner shall if the arrangement, location and construction of the proposed apparatus is proper and in accordance with the provisions of this code, issue a permit for the same. If objection is filed, the application shall be referred to the board of appeal which may in its discretion require the deposit by the objector of a reasonable sum as security for the payment of the costs.

After such notice as the board shall order it shall hear the same and shall direct the commissioner to issue a permit under such conditions as it may prescribe, or to withhold the same. If the permit is refused, the applicant and if it is granted the objectors shall pay such costs as the board may order.

The commissioner may, from time to time, after public notice and hearing, prescribe the conditions on which furnaces, boilers, or other steam generators and hot water heaters may be maintained in buildings, and, if any person interested objects to such conditions and appeals from his decision establishing the same, the appeal shall be referred to the board of appeal, and thereupon said board shall prescribe the conditions.

(b) Each application for a permit with the required fee shall be filed with the commissioner on a form furnished by him and shall contain a general description of the proposed work and its location. It shall be signed by the owner or his authorized agent, and before a permit is issued such application shall also be signed by the person who is to perform or take charge of the work covered by such permit.

(c) Each application hereunder shall indicate the proposed occupancy of all parts of the building and of that portion of the lot, if any, not covered by the building, and shall contain such other information as may be required by the commissioner.

(d) The commissioner may require the material facts contained in each such application to be certified by the applicant under oath.

(e) When required by the commissioner, copies of plans drawn with sufficient clarity and detail to indicate the nature and character of the work shall accompany every such application, and shall be filed in duplicate with the commissioner. Such plans shall contain information, in the form of notes or otherwise, as to the quality of materials where quality is essential to conformity with this code. Such information shall be specific, and this code shall not be cited as a whole or in part, nor shall the term "legal" or its equivalent be used, as a substitute for specific information.

(f) The commissioner may require details, computations, stress diagrams and other data necessary to describe the construction and basis of calculations. He may also require plans showing the location of the proposed building and of every existing building on the lot. He may require structural plans and computations to bear the signature of the architect or engineer in charge

of the structural design, and plot plans to bear the signature of an approved surveyor.

(g) An application for a permit for any proposed work shall be deemed to have been abandoned six months after the date of filing, unless within such time a permit shall have been issued; provided, that for cause one or more extensions of time for periods of not exceeding ninety days each may be allowed in writing by the commissioner.

(h) The commissioner shall examine each application for permit and the plans and computations filed therewith and shall ascertain by examination whether the construction indicated and described is in accordance with the requirements of this code and of all other pertinent laws or ordinances.

(i) The commissioner may accept an application for a permit accompanied by plans and computations and an affidavit filed therewith by a competent architect or engineer to the effect that said plans and computations are in accordance with the requirements of this code and of all other pertinent laws or ordinances.

[**As amended by Ord. 1943, ch. 2*]

†**Sect. 111. Permits.**— (a) If the commissioner is satisfied that the work described in an application for permit conforms to the requirements of this code and other pertinent laws and ordinances, and if the person designated by signature on the application as the person who will perform or take charge of the work is duly licensed, the commissioner shall issue a permit therefor to the applicant; provided, that if the work to be done, in the opinion of the commissioner, is of minor importance, and of such simple character that its execution by an unlicensed person will not endanger the public or any workman engaged thereon, the commissioner need not require the signature to be that of a licensed person but may issue the permit applied for after entering upon the application his reason for waiving such requirement.

(b) If the application for a permit and the plans filed therewith describe work which does not conform to the requirements of this code or other pertinent laws or ordinances, the commissioner shall not issue a permit, but shall return the plans to the applicant with his refusal to issue such permit. Such refusal when requested shall be in writing and shall contain the reasons therefor.

(c) Permits for ordinary repairs, for minor alterations not involving vital structural changes, may be issued upon presentation of an application on a special form, to be furnished by the commissioner, and payment of the required fee.

(d) When application for permit to erect or enlarge a building has been filed, and pending issuance of such permit, the commissioner may, in his discretion, upon payment of the required fee, issue a special permit for the foundations of such building. The holder of such a special permit shall proceed only at his own risk and without assurance that a permit for the superstructure will be granted.

(e) The commissioner shall act upon an application for a permit with plans as filed, or as amended, without unreasonable or unnecessary delay. A permit issued shall be construed to be a license to proceed with the work and shall not be construed as authority to violate, cancel, alter or set aside any

of the provisions of this code, nor shall such issuance of a permit prevent the commissioner from thereafter requiring correction of errors in plans or in construction or of violations of this code. Any permit issued shall become invalid unless the work authorized by it shall have been commenced within six months after its issuance; provided, that for cause one or more extensions of time, for periods not exceeding three months each, may be allowed in writing by the commissioner, except that in no event shall the time for commencing the work be extended beyond eighteen months after the issuance of the permit. Any permit issued may be revoked by the commissioner at any time after notice and hearing if there is a false statement or misrepresentation of a material fact in the application for the permit or in the plans or computations filed therewith, or if the work authorized by the permit violates any provision of this code or other provision of law or the permit is otherwise issued in error, or if in the course of the work there is any violation of any provision of this code or other provision of law, or if after commencement of the work there is unreasonable delay in completing the work, or if there is other good cause for revocation of the permit.

(f) When the commissioner issues a permit he shall endorse in writing, or stamp, duplicate sets of plans "Approved". One set of plans so approved shall be retained by the commissioner and the other set shall be returned to the applicant, shall be kept at the site of work and shall be open to inspection at all reasonable times by the commissioner or his authorized representative.

(g) An architect, engineer or builder who is preparing plans for a building or structure in the city of Boston may make written request of the commissioner for an interpretation of this code as specifically applicable to such building or structure. The request shall be made on a form furnished by the commissioner, shall indicate the specific provision of this code as to which interpretation is so desired, shall be accompanied by the required fee, and shall contain or be accompanied by a description of the proposed work with plans sufficient to enable the commissioner to form an opinion. The commissioner shall make reply in writing within thirty days after receipt of the request either that the description of the proposed work is inadequate to form the basis of an opinion, or that he discerns no reason under the indicated provision of this code for disallowing the proposed construction, or that his interpretation of such provision will not allow the proposed construction for reasons which he shall state. If the commissioner shall interpret such provision as not allowing the proposed construction, such interpretation shall be deemed a disallowance thereof and any person deeming himself aggrieved thereby may appeal from such disallowance as provided in section one hundred and eighteen.

(h) Whenever a permit is to be issued in reliance upon an affidavit as provided in paragraph (i) of section one hundred and ten or whenever the work to be covered by a permit involves construction under conditions which, in the opinion of the commissioner, are hazardous or complex, the commissioner shall require that the architect or engineer who signed the affidavit or made the plans or computations shall supervise such work, be responsible for its conformity with the approved plans, and forthwith upon its completion

make and file with the commissioner written affidavit that the work has been done in conformity with the approved plans and with the structural provisions of this code. In the event that such architect or engineer is not available a competent person whose qualifications are approved by the commissioner shall be employed by the owner in his stead.

[† *As amended by Ord. 1943, ch. 2 and Ord. 1953, ch. 7*]

‡**Sect. 112. Fees.**— (a) Whoever applies for a permit shall pay, at the time of filing his application, the fee established under authority of chapter two hundred and ninety-seven of the acts of nineteen hundred and thirty-one as amended by Chapter 173 of the acts of nineteen hundred and thirty-nine.

(b) The commissioner, with the approval of the mayor, may establish and from time to time alter or amend fees —

(1) For producing for inspection the plans of buildings, as provided in section one hundred and nine.

(2) For issuance of a special foundation permit, as provided in paragraph (d) of section one hundred and eleven.

(3) For written interpretation of this code given for the purpose of an appeal from a disallowance as provided in paragraph (g) of said section one hundred and eleven.

(c) No fee paid in connection with an application for a permit shall be returned, whether or not the permit is granted.

[‡*As amended by Ord. 1943, ch. 2*]

Note—Chapter 297 of the Acts of 1931 was affected by Stat. 1949, ch. 222, which gave to the City of Boston authority to fix certain fees and charges.

Sect. 113. Inspection.— (a) The commissioner shall examine each site, application for permit to erect or enlarge a building or structure upon which has been received, and shall examine all buildings, applications for permit to enlarge, alter, repair, move, demolish or change the occupancy of which has been received. He shall inspect all such buildings and structures from time to time during and finally upon the completion of their erection, enlargement, alteration, repair, moving or demolition. He shall make a record of every such examination and inspection and of all violations of this code. The publication of such records shall be privileged.

(b) No building operation requiring a permit shall be commenced until the permit holder or his authorized agent shall have posted a building permit card in a conspicuous place protected from the weather on the front of the premises and in such a position as to permit the commissioner to make the required entries thereon respecting inspection of the work. Such card shall be preserved and shall remain posted until the completion of the work.

***Sect. 114. Posting Floor Loads.**— No pre-code or post-code building shall be occupied for any purpose which will cause the floors thereof to be loaded beyond their safe capacity as specified in this code; provided, that the commissioner may permit occupancy of a building for mercantile, commercial or industrial purposes, by a specific business, when he is satisfied that such safe capacity will not thereby be exceeded, even though the class of occupancy of such business, under this code, requires a greater load capacity.

In every such case the safe floor loads, as determined by the commissioner, shall be marked on metal plates of approved design which shall be supplied and securely affixed by the owner of the building in a conspicuous place in each story to which they relate. Such plates shall not be removed or defaced, and if lost, removed or defaced shall be replaced by such owner. No such owner shall place or permit to be placed, or to remain on any floor of a building a greater load than the safe load so determined and posted.

[**As amended by Ord. 1943, ch. 2*]

†**Sect. 115. Annual Report.**—The commissioner shall annually, not later than May first, submit a report to the mayor, covering the work of the department during the preceding calendar year, and shall incorporate in said report a summary of the decisions of the board of appeal, a summary of the proceedings of the board of examiners and of the board of examiners of gas fitters, during said year, and his recommendations as to desirable amendments of this code.

[*†As amended by Ord. 1943, ch. 2*]

‡**Sect. 116. Powers and Duties of Building Commissioner.—(a)** The commissioner and the health commissioner shall severally enforce the provisions of this code relative to his powers and duties and they may, themselves or by their respective duly authorized representatives, enter any building or premises in said city to perform any duty imposed upon them, respectively, by this code.

(b) Upon notice from the commissioner that work on any building or structure is being done contrary to the provisions of this code or in a dangerous or unsafe manner, such work shall be immediately stopped. Such notice shall be in writing and given to the owner of the property, or his agent, or the licensed builder or mechanic doing the work, and shall state the conditions under which work may be resumed.

(c) Whoever hinders or prevents, or attempts to hinder or prevent, the commissioner or his authorized representative from entering a building, structure or enclosure, or part thereof, in the performance of his duty in the enforcement of any provision of this code shall be punished by a fine of not less than fifty nor more than one hundred dollars. Each day during any portion of which such hindering continues shall be considered a separate offence.

(d) Every building of which the exits are insufficient shall be provided with exits satisfactory to the commissioner; and every building which is dangerous or unsafe shall be made safe or removed; or every such building shall be vacated forthwith on order of the commissioner, with the approval of the mayor. Such order shall be in writing and shall be addressed and delivered, or mailed, postage prepaid, to the owner or tenant, if he is known and can be found, or otherwise by posting an attested copy of the order in a conspicuous place upon an external wall of the building, and shall state the conditions under which the building may again be used or occupied. An attested copy so posted shall not be defaced or removed without the approval of the commissioner. If in the opinion of the commissioner the public safety so requires the commissioner, with the approval of the mayor, may at once enter the building or other structure which he finds unsafe or dangerous, or land

on which it stands, or the abutting land or buildings, with such assistance as he may require, and make safe or remove said unsafe or dangerous building or other structure and may protect the public by a proper fence or otherwise as may be necessary, and for this purpose may close a public or private way

*(e) A claim for the expense incurred by the commissioner under paragraph (d) shall constitute a debt due the city upon completion of the work and rendering to the owner of an account therefor and recoverable from the owner in an action of contract. Said debt, together with interest thereon at the rate of six per cent per annum from the date upon which said debt became due, shall constitute a lien upon the real estate on which the expense was incurred in the manner hereafter provided. Such lien shall take effect upon the filing, within ninety days after the debt became due, for record in the registry of deeds for Suffolk county, or in the case of registered land with the assistant recorder for the Suffolk district, of a statement of the claim, signed by the commissioner, setting forth the amount claimed without interest. Such lien shall continue for two years from the first day of October next following the date of filing said statement. Such lien may be dissolved by filing for record in such registry of deeds or with said assistant recorder as the case may be, a certificate from the collector-treasurer that the debt for which such lien attached, together with interest and costs thereon, has been paid or legally abated. The collector-treasurer shall have the same powers and be subject to the same duties with respect to such claim as in the case of the annual taxes upon real estate; and the provisions of law relative to the collection of such annual taxes, the sale or taking of land for the non-payment thereof, and the redemption of land so sold or taken shall apply.

(f) The owner of the real estate to which a lien has attached, as provided in paragraph (e), within ninety days after the statement of said lien was filed in the registry of deeds or with said assistant recorder, as the case may be, may appeal to the municipal court of the city of Boston, which shall hear and determine after a hearing whether the amount of the claim is more than the amount actually expended to make safe or remove the building or structure, if amount is more, said court may reduce the amount of the claim to the amount so actually expended.

(g) Any requirement necessary for the strength or stability of a pre-code or proposed structure or for the safety of the occupants thereof, not specifically covered by this code, shall be determined by the commissioner subject to appeal to the board of appeal.

(h) The commissioner shall examine every building reported as dangerous or damaged, and shall make a written record of such examination, stating the nature and estimated amount of the damage, and the purpose for which the building was used, and in case of fire the probable origin thereof.

(i) The owners of buildings in Boston shall comply with, and all materials used and work performed in gas fitting in Boston shall be in accordance with, the rules and regulations from time to time in effect under the provisions of section twelve H of chapter twenty-five of the General Laws, except as such rules and regulations may be varied under the provisions of sections

one hundred and seventeen, one hundred and eighteen and one hundred and nineteen of this code. The commissioner and the health commissioner of the city of Boston shall severally have power to inspect from time to time gas fixtures and appliances in any and all buildings in Boston and to compel compliance in Boston with the rules and regulations aforesaid.

(j) The commissioner shall make and issue rules and regulations governing the tearing down of buildings.

(k) The provisions of this section shall apply to pre-code as well as post-code buildings.

(l) Whoever desires to substitute for the materials or methods covered by this code, materials or methods of construction or maintenance not covered thereby, shall present to the commissioner plans, methods of analysis, and tests or other information substantiating the analysis of the system or qualities of the material and shall make such additional tests or present satisfactory evidence of such tests as the commissioner may require. The costs of any tests required to determine acceptability of substitute materials or methods shall be paid by the applicant. When the strength of any construction cannot be satisfactorily determined by the application of accepted engineering principles, its safe strength shall be determined as one sixth of the ultimate strength evidenced by tests of full size units or assemblies thereof of such construction so loaded as to produce critical stresses. Such materials or methods of construction shall not be used until after the commissioner has issued regulations fixing the practices to be followed, but no such regulation shall have the effect of altering the working stresses for any material herein mentioned or of reducing the fire-resistive and fire-protective requirements of this code; provided, that any such regulation fixing the practices to be followed in the use of any such material may reduce the fire-resistive or fire-protective requirements of this code if in promulgating such regulation the commissioner certifies, on the basis of reports on file in his office as to tests of such material made in accordance with standard specifications of the American Society for Testing Materials, that in his opinion such material used in accordance with such regulation will provide substantially as much safety from fire as materia meeting such fire-resistive and fire-protective requiremtns.

[*As amended by Ord. 1943, ch. 2 and ch. 737 of 1960*]

[**As amended by ch. 234, Acts 1958*]

[***As amended Ord. 1957, ch. 11*]

***Sect. 117. Board of Appeal.— (a)** There is hereby established in the city of Boston a board, to be called the board of appeal, and to consist of five members appointed by the mayor in the following manner: — One member from two candidates, one to be nominated by the Boston Real Estate Exchange and one by the Massachusetts Real Estate Exchange; one member from two candidates, one to be nominated by the Boston Society of Architects and one by the Boston Society of Civil Engineers; one member from three candidates, one to be nominated by the Master Builders Association, one by

the Building Trades Employers' Association and one by the Building Contractors Association of Massachusetts, Inc.; one member from two candidates to be nominated by the Building Trades Council of Boston and Vicinity; and one member selected by the mayor.

(b) Upon the expiration of the term of office of a member of said board in office on the effective date of this code his successor shall be appointed for the term of five years; and subsequent appointments to said board shall be for terms of five years each. Vacancies shall be filled for an unexpired term in the manner in which original appointments are required to be made. Each member of the board of appeal shall receive for every day or part thereof of actual service twenty dollars or such other sum as may from time to time be fixed by the city council with the approval of the mayor; but no member shall so receive in any one year more than fifteen hundred dollars or such other sum as may from time to time be fixed by the city council with the approval of the mayor. No member shall act in a case in which he has a personal interest, and when a member is so disqualified, or absent, the remaining members shall designate a substitute.

Note—Chapter 6 of the Ordinances of 1952 provides: "Each member of the board of appeal shall receive for every day or part thereof of actual service twenty-five dollars, but in no event shall any member of said board receive in any one year more than thirty-five hundred dollars in the aggregate for services rendered by him under the building code and the zoning law. . . ." Effective January 1, 1953.

(c) Members of said board shall be residents of or engaged in business in the city of Boston.

(d) Said board shall cause to be made a detailed record of all its proceedings, which shall set forth the reasons for its decisions, the vote of each member participating therein, the absence of a member, the name of his substitute and any failure of a member to vote.

(e) The board shall establish rules and regulations for its own procedure not inconsistent with this code.

[* *As amended by Stat. 1949, ch. 201, and Stat. 1952, ch. 212*]

Sect. 118. Appeals.— **(a)** A person whose application for a permit has been refused by the commissioner may appeal to said board of appeal within ninety days thereafter. A person who has been ordered by the commissioner to incur expense may so appeal therefrom within thirty days of the date of such order, except that, in case of a building or structure which, in the opinion of the commissioner, is unsafe or dangerous, the commissioner may in his order limit the time for such appeal to a shorter period. A person aggrieved by an adverse interpretation of this code and a disallowance by the commissioner of proposed construction thereunder, as provided in section one hundred and eleven, may so appeal from such disallowance within thirty days after the date thereof. Appeals hereunder shall be on forms provided by the commissioner and shall be accompanied by such fee as may be established by the commissioner, with the approval of the mayor.

(b) The commissioner may refer without fee to the board of appeal for its decision such cases as, in his opinion, justice requires.

†**Sect. 119. Decisions of the Board of Appeal.**— (a) The board of appeal, when so appealed to and after a hearing, may vary the application of any provision of this code to any particular case when in its opinion the enforcement thereof would do manifest injustice, provided that the decision of the board shall not conflict with the spirit of any provision of this code.

(b) Every decision of said board shall be in writing, shall indicate the vote of each member upon the decision, and if it is to vary the application of any provision of this code or modify an order of the commissioner, shall require the assent of at least four members. Every decision shall promptly be filed in the office of the commissioner, and shall be open to public inspection; a certified copy shall be sent by mail or otherwise to the appellant and a copy shall be kept publicly posted in the office of the commissioner for two weeks after filing.

(c) A decision of said board to vary the application of any provision of this code or modify an order of the commissioner shall specify in what manner such variation or modification, respectively, is made, the conditions upon which it is made and the reasons therefor.

(d) Said board shall in every case reach a decision without unreasonable or unnecessary delay.

(e) If the refusal, order or disallowance of the commissioner is reversed or modified, or the application of any provision of this code is varied by a decision of said board, the commissioner shall immediately take action in accordance with such decision; but no decision of said board shall be regarded as establishing a precedent or be held to amend this code or the commissioner's interpretation thereof.

(f) A person aggrieved by a decision of said board, whether previously a party to the proceeding or not, or a municipal officer or board, may, within fifteen days after the filing of such decision in the office of the commissioner, bring a petition in the supreme judicial court for the county of Suffolk for a writ of certiorari to correct errors of law in such decision, and the provisions of section four of chapter two hundred and forty-nine of the General Laws shall, except as hereinbefore provided, apply to such petition.

The person filing the petition shall file a bond with sufficient surety, to be approved by the court, for such sum as shall be fixed by the court, to indemnify and save harmless the person or persons in whose favor the decision was rendered from all damages and costs which they may sustain in case the decision of said board is affirmed. In case the decision of the board is affirmed the court, on motion, shall assess damages, and execution shall issue therefor.

[*†As amended by Ord. 1943, ch. 2*]

‡**Sect. 120. Board of Examiners.**— (a) There is hereby established in the City of Boston a Board of Examiners to consist of three members appointed by the Mayor. The Board shall consist of an engineer or architect with at least five years' experience in the City of Boston, a contractor or person well qualified in the supervision of construction work with at least five years' experience in the City of Boston, and a lawyer or other person with proper legal qualifications. Said Board shall exercise the powers and perform the duty herein provided. Upon the expiration of the term of office of a member of said Board in office on the effective date of this code, his successor shall be appointed for the term of three years; and subsequent appointments to said Board shall be for terms of three years each. Vacancies

shall be filled by appointments by the Mayor for the remainder of the unexpired term. Each member of the board of examiners shall receive for every day or part thereof of actual service ten dollars or such other sum as may from time to time be fixed by the city council with the approval of the mayor; but no member shall so receive in any one year more than one thousand dollars or such other sum as may from time to time be fixed by the city council with the approval of the mayor.

Note—Section 6 of the Ordinances of 1952 provides: "Each member of the board of examiners, and the appointive member of the board of examiners of gasfitters, shall receive for every day or part thereof of actual service fifteen dollars, but in no event more than fifteen hundred dollars in any one year."

(b)* The board of examiners shall hold examinations, under rules and regulations adopted by it, of persons desiring to be registered as qualified to have charge or control of the construction, alteration, removal or tearing down of buildings or structures. Due notice of the time and place for such examinations shall be posted in the office of the building department and published in the City Record.

Note—Stat. 1945, Chap. 626, provides that the licensing of elevator and escalator mechanics shall be under the jurisdiction of the State Department of Public Safety.

(c) Said board shall establish various classes of persons to be registered, shall determine the qualifications required for each class, and after examination shall register in each class the persons found to possess the requisite qualifications therefor. The name and address of each person so found to be qualified, with the designation of the class in which he is registered, shall thereupon be certified by said board to the commissioner, who shall make a record thereof, which shall be open to public inspection.

(d) Except as otherwise provided in section one hundred and eleven, all work of erecting, enlarging, altering, repairing, moving and demolishing of buildings or structures and installing and repairing of elevators and escalators in the city of Boston shall be under the charge, control and personal supervision of a licensed builder or mechanic, qualified by education, training and experience for the performance of that duty in a manner which shall preserve the public safety and conform to this code and all other pertinent laws and ordinances.

(e) Any person who shall by affidavit, together with such other evidence as may be required by said board, show to it that he has had charge or control of such work in the class in which he applies to be registered, and shall satisfy the board that he is qualified by education, training and experience to have charge or control of such work, may, without other examination, be registered in such class and be certified to the commissioner as a person qualified within such class.

(f) Said board, upon payment of the required fee, shall issue a license to each person so certified by it to the commissioner. Each license shall

expire one year from the date of its issuance. Said board shall renew a license, upon the expiration thereof and upon payment of the required fee therefor, for the further period of one year from the date of renewal. The fees to be paid to said board for such licenses and renewals shall be as provided in chapter two hundred and ninety-seven of the acts of nineteen hundred and thirty-one, as amended by Chapter 173 of the acts of nineteen hundred and thirty-nine.

(g) Any person who is duly licensed as aforesaid shall be entitled to have charge or control of any work described in this section, in the class in which he is registered, until his license is revoked or suspended by the commissioner, upon the order of said board. No such license shall be revoked or suspended except upon proof, satisfactory to said board, or specific charges, filed with said board by the commissioner or other person, that the licensee has been careless or negligent in the performance of his duty in connection with work under his charge or control, or has caused or permitted a violation of this code in connection therewith, or that this code has been violated in connection with such work and that the licensee, being in charge of such work, knew, or, in the exercise of due diligence, should have known, of such violation. Upon learning of such carelessness, neglect of duty or violation of this code, the commissioner shall file charges with said board and prosecute them. Upon the filing thereof by the commissioner or other person, said board shall give to the licensee notice of a hearing thereon, which hearing shall be held by said board not less than seven days after date of said notice. Such notice shall be served upon the licensee either by service in hand or by registered mail, shall state the time and place of the hearing and shall contain a copy of the charges. At such hearing the licensee may be represented by counsel, and the commissioner may be assisted by a representative of the law department of the city.

(h) If, for any cause, a person licensed as herein provided shall cease to have charge or control of work described in this section before such work is finished, the work shall stop until another person duly licensed for the doing of such work has been placed in charge thereof.

(i) Whoever violates any provision of this section shall be punished by a fine of not more than fifty dollars.

[‡*As amended by Stat. 1952, ch. 212 and Ord. 1943, ch. 2*]

[**As amended by ch. 227, Acts of 1959*]

***Sect. 121. Board of Examiners of Gasfitters.**— (a) There is hereby established in the city of Boston a board of examiners of gasfitters, to consist of three members, who shall be the building commissioner, the health commissioner and a licensed master gasfitter. The member of the board of examiners of gasfitters who is a licensed master gasfitter shall be appointed annually by the mayor for a term ending on the first day of May of the year next ensuing; and he shall receive for every day or part thereof of actual service ten dollars or such other sum as may from time to time be fixed by the city council with the approval of the mayor. He shall have been continuously engaged in business as a master gasfitter during the five years next preceding his appointment.

Note—See note under Sect. 120, par. (a).

(b) Said board shall hold examinations, under rules and regulations adopted by it, of persons desiring to engage in business as master gasfitters or to work as journeyman gasfitters. Due notice of the time and place for such examinations shall be posted in the office of the department and published in the City Record.

(c) Said board shall determine the qualifications required for registration as master gasfitter and as journeyman gasfitter, and after examination shall register as such the persons found to possess the requisite qualifications. Said board shall, without re-examination, register as qualified master gasfitters or journeyman gasfitters, as the case may be, persons desiring so to be registered who were so licensed before the effective date of this code. The name and address of each person so found to be qualified and registered, and the place of business of each person qualified as a master gasfitter, shall thereupon be certified by said board to the commissioner who shall, upon payment of the required fee, issue to each person so registered and certified a license to engage in business as a master gasfitter or to work as a journeyman gasfitter, as the case may be.

(d) Every original license issued under this section shall take effect upon its issuance and shall expire on such date, not later than one year after its effective date, as said board shall determine. Upon the expiration of any license issued under this section, the commissioner shall, upon payment of the required fee, renew the same except that, unless otherwise ordered by said board, he shall not renew the license of any person whose registration has been cancelled or whose license has been revoked or suspended. Every renewal license issued under this section shall take effect on such date, not later than one month after its issuance, and expire on such date, not later than one year after its effective date, as said board shall from time to time determine. The registration of any person whose license has not been renewed within one year after its expiration shall be cancelled.

(e) The fee for issuance or renewal of a master gasfitter's license shall be two dollars and that for issuance or renewal of a journeyman gasfitter's license shall be fifty cents; provided, that such fees may be changed from time to time by the building commissioner, with the approval of the mayor.

(f) Except as otherwise provided in this section all gas fitting in buildings shall be done by licensed master gasfitters, either themselves or through licensed journeymen gasfitters employed by them. A firm or corporation employing journeymen gasfitters shall be deemed to be licensed for the purpose of this section if a member of the firm or an officer of the corporation is duly licensed as a master gasfitter. A permit for gas fitting in buildings shall be issued only to licensed master gasfitters.

(g) No person shall connect, disconnect or remove a gas meter, except the duly authorized representative of the gas company owning such meter. Nothing in this section shall be construed to affect the operations of a gas company upon its own premises or upon its mains and service pipes.

(h) Whoever violates any provision of this section shall be punished by a fine of not more than one hundred dollars, and, in addition, if the offender is licensed under this section, his license shall be revoked or suspended by the commissioner, when so ordered by said board after a hearing.

[*As amended by Stat. 1952, ch. 212, Stat. 1955, ch. 4, and Ord. 1943, ch. 2]

Sect. 122. Penalties.— (a) A building or structure which is erected or maintained in violation of any provision of this code shall be deemed a common nuisance without other proof thereof than proof of the unlawful construction or maintenance, and the commissioner may abate and remove it in the same manner in which boards of health may remove nuisances under sections one hundred and twenty-three to one hundred and twenty-five, inclusive, of chapter one hundred and eleven of the General Laws.

(b) Except as otherwise provided in this code, whoever violates any provision thereof, or whoever builds, alters, or maintains a structure or a part thereof in violation of any provision thereof, shall be punished by a fine of not exceeding five hundred dollars. Each day during any portion of which such violation is allowed to continue, or is permitted by the owner, shall be considered a separate offence.

Section 123. Enforcement Jurisdiction.— (a) Any court having jurisdiction in equity, or any justice thereof, may, upon the application of the city by its attorney —

(1) Restrain the construction, alteration, repair, maintenance, use or occupation of any building or structure constructed, maintained, used or occupied in violation of any provision of this code, and order its removal or abatement as a nuisance;

(2) Restrain the further construction, alteration, repair, maintenance, use or occupation of any building or structure which is unsafe or dangerous;

(3) Restrain the unlawful construction, alteration, repair, maintenance, use or occupation of any building or structure;

(4) Compel compliance with the provisions of this code;

(5) Order the removal by the owner of a building or structure unlawfully existing and authorize the commissioner, with the written approval of the mayor, in default of such removal by the owner, to remove it at the owner's expense.

(b) The municipal court of the city of Boston, concurrently with the superior court, shall have jurisdiction throughout the city of prosecutions and proceedings at law under the provisions of this code, and all other pertinent laws and ordinances.

(c) Upon the entry of any case brought under any provision of this code the court shall, at the request of either party, advance the case, so that it may be heard and determined with as little delay as possible.

***Sect. 124. Classification of Buildings by Types of Construction.—**

(a) Buildings shall be classified by types of construction representing varying degrees of resistance to fire. All buildings required to be of a given type of construction shall conform to the minimum requirements of this code for that type, but materials and combinations of materials which offer greater resistance to fire than those specified for minimum requirements may be used. Every building shall be classified as of the most fire-resistive type all of the minimum requirements of which it fully meets. No building or portion thereof shall be required to conform to a type of construction more fire-resistive than that specified for its occupancy and size, or for its location in the fire zones, in this code.

(b) When two or more types of construction occur in the same building and are separated as provided in this code, each portion so separated may be classified as of the type of construction to which it conforms; otherwise the entire building shall be classified as of the least fire-resistive type of construction used, and shall be subject to the restrictions of this code imposed upon that type.

(c) A pre-code building which cannot be definitely classified as one of the types defined in sections one hundred and twenty-five to one hundred and thirty-one, inclusive, shall be deemed for the purpose of this code to belong to the less fire-resistive of the two types to which it most nearly conforms.

[**As amended by Ord. 1943, ch. 2*]

Sect. 125. Types of Construction.— All buildings shall be classified for the purpose of this code in the following types of construction:—

Type I. Fireproof.
Type II. Semi-Fireproof.
Type III. Heavy Timber and Masonry.
Type IV. Light Wood and Masonry.
Type V. Metal Frame.
Type VI. Wooden Frame.

Sect. 126. Type I, Fireproof Construction.— Buildings of Type I construction shall be of incombustible materials in all structural parts; their exterior bearing walls and frames shall be of four-hour fire-resistive construction and their floors and roofs shall be of three-hour fire resistive construction and shall furnish protection of three-hour fire-resistive rating against the spread of fire.

Sect. 127. Type II, Semi-Fireproof Construction.— Buildings of Type II construction shall be of incombustible materials in all structural parts; their exterior bearing walls shall be of four-hour fire-resistive construction, their columns and frames shall be of two-hour fire-resistive construction and their floors and roofs shall be of one-hour fire-resistive construction and shall furnish protection of one-hour fire-resistive rating against the spread of fire.

Sect. 128. Type III, Heavy Timber and Masonry Construction.— Buildings of Type III shall have exterior bearing walls of masonry or other construction of incombustible materials of four-hour fire-resistive construction, and their frames, floors and roofs shall be of heavy timber construction without concealed air spaces.

Sect. 129. Type IV, Light Wood and Masonry Construction.— Buildings of Type IV shall have exterior bearing walls of masonry or other construction of incombustible materials of four-hour fire-resistive construction and their frames, floors and roofs may be of wood.

Sect. 130. Type V, Metal Frame Construction.— Buildings of Type V shall have walls, frames, floors and roofs of metal or other incombustible materials which may be without protection against fire.

Sect. 131. Type VI, Wooden Frame Construction.— Buildings of Type VI may have walls, frames, floors and roofs of wood.

***Sect. 132. Occupancies classified.**— (a) Every building, whether pre-code or post-code, shall, for the purpose of this code, be classified according to its principal occupancy, as follows:—

Group A. Theatres.
Group B. Halls.
Group C. Schools.
Group D. Hospitals and detention buildings.
Group E. Commercial buildings of hazardous occupancy.
Group F. Offices and commercial buildings.
Group G. Commercial buildings of non-hazardous occupancy.
Group H. Unlimited habitations and large dwellings.
Group I. Limited habitations and small dwellings.
Group J. Miscellaneous structures.

(b) An occupancy not mentioned specifically in this section or in the definitions of groups and sub-divisions of groups contained in Parts 3 to 12, inclusive, of this code, or about which there is any question, shall be classified by the commissioner and included in the group which it most nearly resembles, as regards fire hazard and danger to the lives of persons.

[**As amended by Ord. 1943, ch. 2*]

†**Sect. 133. Change of Occupancy.**— The occupancy of a building shall not be changed unless such building conforms or is made to conform with the requirements of this code for the group in which it is to be classified, except that the occupancy of a pre-code building may be changed as provided in section one hundred and seven.

[*†As amended by Ord. 1943, ch. 2*]

Sect. 134. Multiple Occupancies.— When a building contains two or more units of occupancy, whether of the same or of different occupancy classifications, the separations between such units and the aggregate area of such units within the building shall be as provided in this code.

Sect. 135. Elevators and Escalators.— No elevator or escalator shal be installed in a building or structure except under the provisions of sections sixty-two to seventy-one, inclusive, of chapter one hundred and forty-three of the General Laws and the regulations issued thereunder, and in conformity with section one hundred and twenty of this code.

Sect. 136. Building Height.— (a) No building or structure shall be so erected or altered that any part thereof shall be higher above the ground than two and one half times the shortest horizontal distance of that part from the further side of the street upon which it fronts; provided, that, in case of a building at the intersection of two streets, within one hundred and fifty feet measured along the streets from the intersection of the nearer side lines thereof, the width of each street shall for the purpose of this section be taken as the width of the wider street.

(b) No building or structure shall be erected or altered to a greater height measured to the highest point of the roof thereof than one hundred and fifty-five feet except as provided in this paragraph. If a building or structure shall be erected or altered to a greater height than one hundred and fifty-five feet every part of such building shall not be higher above the ground than one hundred and twenty-five feet plus two and one half times the shortest horizontal distance of that part from the nearest lot or street line. No building shall be erected or enlarged to contain a volume above the grade of the ground greater than the buildable area of the lot multiplied by one hundred and fifty-five feet.

(c) In determining the height of any part of a building for the purposes of this section, the grade of the ground from which measurement shall be made shall be that from which the height of the building is measured as defined in section one hundred and six. Flag poles and weather vanes shall not be considered a part of a building for the purposes of this section.

PART 2.

FIRE LIMITS.

Section 201. Fire Limits.— For the purposes of this code there shall be established in the city of Boston two fire districts or zones within which building construction shall be limited as provided in this part of the code. Outside of the boundaries of the zones no limitation is placed by this part of the code upon the construction of buildings.

Sect. 202. Boundaries.— (a) The boundaries of the first fire zone shall be the boundaries of the building limits as they existed prior to the twenty-second day of September in the year nineteen hundred and thirteen.

(b) The boundaries of the second fire zone shall be the boundaries of the building limits as they were established on and after the twenty-second day of September in the year nineteen hundred and thirteen.

(c) The city council of the city of Boston may by ordinance from time to time extend either fire zone and re-establish its boundaries.

***Sect. 203. Construction within the Fire Zones.**— (a) Buildings hereafter erected in the first or second fire zone shall be of Type I, Type II, Type III or Type IV construction except as hereinafter provided.

(b) The limitations of this section shall not apply to buildings not over twenty-seven feet high on wharves and buildings for the storage and handling of coal or grain in bulk, of Type V or Type VI construction, in either fire zone, if the exterior thereof is covered with slate, tin, sheet metal or other equally fire-resistive construction, erected with the approval of the commissioner and subject to such conditions as he may in each case specify.

(c) Temporary structures to be used in connection with construction work and temporary reviewing stands, frame-works and tents, as are customarily used exclusively for outdoor carnivals, lawn parties or like activities, may be erected in either fire zone and of any type of construction, subject to the approval of the commissioner, and to such conditions and for such time as he may in each case specify.

(d) Buildings of Type VI construction for dwellings for one or two families may be erected or enlarged in the second fire zone where the area of each does not exceed sixty per cent of the area of the lot on which it is located and the roof is pitched at not less than thirty degrees with the horizontal.

(e) Buildings of Type V construction may be erected or enlarged for use as garages in the second fire zone providing they are equipped with fire windows and are not within two feet of a lot line or within five feet of a building of Type VI construction and the height does not exceed one story and the area six hundred square feet and the capacity two cars.

(f) Buildings of Type V construction for other occupancies may be erected in the second fire zone providing the location and the occupancy are approved by the building commissioner.

(g) Buildings in the first or second fire zone erected, enlarged or converted to use as a garage for more than four cars shall be of Type I or Type II construction and if such garage be more than one story in height it shall be of Type I construction.

(h) Every building in Group C in the first or second fire zone shall be of Type I or Type II construction.

[**As amended by Ord. 1945, ch. 6*]

PART 3.

SPECIAL REQUIREMENTS FOR GROUP A OCCUPANCY: THEATRES.

Section 301. Group A Occupancy: Type, Height, Area.— (a) Group A shall include every building containing an auditorium and a permanent stage equipped with a gridiron or other means of hanging scenery, and primarily adapted for the giving of plays, operas or similar forms of entertainment.

(b) Buildings or parts of buildings, classified for occupancy in Group A, shall be of Type I construction, except that portion of the stage which, under the provisions of section three hundred and eleven, may be of wood or unprotected metal, and they shall not hereby be limited as to seating capacity, area or height.

Sect. 302. Separation of Occupancies.— Portions of a building of Group A occupancy may be used for purposes other than the giving of plays, operas and the like, but the parts given to such other occupancies shall be separated from that devoted to Group A occupancy by separations specified in Part 13.

***Sect. 303. Exterior Walls.**—(a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be without openings, except that openings in such walls at the ends of courts shall be allowed when protected by fire windows or Class B fire doors. Openings in such walls or parts of walls which are five feet or more but less than ten feet from a property line shall be protected by fire windows or Class B fire doors.

(b) In an exterior wall, every opening which faces, at a distance of less than twenty feet, the further side of a street or a combustible wall or roof or an unprotected opening in a wall or roof of another building on the same lot, shall be protected by fire windows or Class B fire doors.

(c) The commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

[**As amended by Ord. 1943, ch. 2*]

Sect. 304. Enclosure of Vertical Openings.— (a) Stair or ramp exits from only the first or lower balcony need not be enclosed. Stair or ramp exits from smoking rooms, lounges or other public rooms in the basement shall be enclosed in the basement or first story, and the doors shall be self-closing but need not be fire doors. Other stairways and ramps which pierce only one floor shall be enclosed in the story above or below but such stairway or ramps which serve as required exits from one story shall be enclosed in the other story. Stairways or ramps serving dressing rooms need not be enclosed above the stage or first floor if separated from the stage by a two-hour separation. Other stairways and ramps shall be enclosed in all stories in which they occur. There shall be no openings in stair or ramp enclosures except entrance and exit doorways and the openings required for ventilation.

(b) Vertical openings for elevators serving dressing rooms need not be enclosed above the stage or first floor if they are separated from the stage by a two-hour separation. Vertical openings for elevators serving the gridiron and fly galleries need not be enclosed above the stage level. All other vertical openings for elevators and vertical openings for ventilation or other purposes, except as otherwise specified in this section, shall be enclosed.

†Sect. 305. Exits and Entrances.— (a) Group A buildings shall be so located that the main entrances shall open directly from a public street or streets not less than thirty feet wide. The main entrance or entrances, which may also serve as exits, shall have in the aggregate twenty inches of unobstructed width for each one hundred persons to and including one thousand persons, with an additional ten inches for each additional one hundred persons to and including one thousand additional persons, and an additional five inches for each additional one hundred persons over two thousand, all based on the total seating capacity of the building served by said entrances. No main entrance shall be less than fifteen feet in clear width between walls or in aggregate width of doorways and of passageways but such width shall not be required to exceed forty feet in width. Doorways and passageways in such entrances shall be not less than five feet in clear width.

(b) Adjacent to the main floor and each balcony of the auditorium and between the auditorium and the main entrance, in the path of normal entrance and egress, there shall be a foyer consisting of a lobby, corridor or passageway, one or more, the aggregate floor area of which shall be at least equal to one square foot for each seat in such division of the auditorium.

(c) There shall be at least two remote exits from the main floor and from each balcony of the auditorium. One of these exits from the main floor and one from each balcony shall open into the foyer required therefor in this section. Both such exits may open into the required foyer if it has two remote exits.

(d) From the main floor and each balcony of the auditorium there shall be at least two paths of exit independent of one another. Stairways or ramps serving balconies above the first or lowest balcony shall be enclosed and shall discharge directly into a street or open court independently of the other required exit serving the same balcony or balconies and independently of the paths of exit from the main floor. Such stairways or ramps may serve also as exits from the first or lowest balcony. A stairway or ramp serving as an exit only from the first or lowest balcony need not be enclosed and the path therefrom may join a path of exit from the main floor. Where a path of exit joins another at an angle, the common path of exit shall be at least as wide as the sum of the widths of the paths so joined, and the partition or railing which bounds a path so joining another shall either be stopped back from the nearer side of the common path a distance equal to the width of the joining path or shall extend such distance beyond the side of the common path, thus enabling persons either to join the common path before turning or to enter and turn before joining the common path.

(e) Exit stairways or ramps from balconies shall not extend below the level at which they discharge from the building.

(f) Exits and paths of exit, except from boxes seating less than twenty-five persons, shall be not less than five feet wide at any point. The aggregate width of the paths of exit specified heretofore in this section which serve one or more divisions of the auditorium shall be at least twenty inches for every one hundred persons for whom seats are provided in the division or divisions so served. In calculating the required width of each path of exit, persons seated in the auditorium shall be allotted to those exits therefrom which they can most quickly reach in an emergency, assuming that the emergency exits hereinafter specified are not used, and upon any other reasonable assumption.

(g) In addition to the exits specified in paragraphs (c), (d), (e) and (f) of this section, hereinafter called normal exits, there shall be provided a system of emergency exits as specified in this paragraph and in paragraphs (h) and (i). Emergency exits from the auditorium shall be at least five feet wide and there shall be at least one such exit from each side of the main floor and of each balcony as remote as practicable from the normal exits. Emergency exits from the main floor shall be exits from the building or shall be connected by passageways with exits from the building independent of the normal exits. The paths of emergency exit from the main floor shall be not less than five feet wide, nor shall the aggregate width be less than five inches for every one hundred persons served. The paths of exit from the emergency exits from balconies shall be either of inside type as specified in paragraph (h) or of outside type as specified in paragraph (i) of this section, or a combination of the two types; provided, that the aggregate width of the paths of emergency exit shall have five inches in width of inside path or ten inches in width of outside path for every one hundred seats in the balcony or balconies served.

(h) An inside path of emergency exit, referred to in the preceding paragraph, shall consist of a foyer with at least fifty square feet of floor for each emergency exit served, and an enclosed stairway or ramp with outside ventila-

tion, with a direct exit from the building, or an enclosed passageway leading to such an exit, independent of normal exits, or an exit to another building or fire division of Type I or Type II construction. An exit to another building or fire division shall be through a lobby or vestibule of at least one hundred square feet in floor area with outside ventilation and with self-closing Class A fire doors at entrance and exit and shall lead, through adequate corridors, stairways and passageways, to the street. No such exit shall be made through a building or fire division of Group E occupancy. Inside emergency exits shall be not less than three feet wide.

(i) An outside path of emergency exit, referred to in paragraph (g) of this section, shall consist of an exterior fire escape balcony not less than four feet wide at each emergency exit from a balcony and not more than six inches below the sill thereof. Such balconies at the highest level shall be at least eight feet long and at lower levels at least twelve feet long. Fire escape stairs of rise not exceeding eight and one half inches and tread not less than nine and one half inches and not less than thirty inches wide shall lead from all such balconies to the ground. The lowest runs may be hinged and counterweighted. Exterior fire escapes shall be located either in a street or in an open court. Such courts shall be at least six feet wide and open to the sky for the full depth of the auditorium and shall be connected with a street by an open court or an enclosed passageway ten feet high, either of which shall be at least six feet wide. Every such court or passageway shall have such additional width as may be necessary, if any, to provide, when the fire escape stairs are in position for use, the clear width required for it as a path of emergency exit and as a path of normal exit if so used.

(j) At least one exit, three feet wide, shall be provided on each side of the stage. These exits shall open directly upon a street, or on a passageway or court not less than three feet wide, leading to a street. Ladders may be provided as exits from fly gallery and gridiron. Each tier of dressing rooms shall be provided with at least two remote exits not less than thirty inches wide.

(k) All exit and entrance doors or gates in any path of exit shall swing in the direction of egress and if provided with latches, such latches shall be of self-releasing type such as panic bolts or similar devices, of non-corrodible metal, which will permit the door to open when pressed against. All doors shall be so installed as not in any position to decrease the width of any doorway (except that in which it is installed), stairs, landing, passageway or corridor below the width required.

(l) No mirrors, false doors or windows shall be so placed as to give the appearance of a doorway or exit, hallway or corridor.

(m) In buildings of Group A the rise of stairs shall not exceed seven and one half inches nor shall the tread be less than ten and one half inches. There shall be no flights of stairs of more than fifteen or less than three risers between landings.

(n) A landing between two flights of stairs in the same direction shall be at least as wide as the stairway and at least four feet long in the direction of travel. Stairs turning at a right angle shall have a square or rectangular

landing the full width of the respective stairways, except that the outer line of the landing shall be curved to a radius not less than two feet, or bevelled two feet, to avoid a deep corner. Where stairs return directly on themselves, a landing without steps shall be provided at least as wide as the stairs, and the outer corners shall be curved or bevelled. Winders may be provided only in stairs from boxes seating less than twenty-five persons. Where two side flights of stairs join and continue in a common flight, a landing without winders shall be provided and the width of the common flight shall be equal to the sum of the widths of the side flights. A door opening into a stairway shall not open immediately upon a flight of stairs, but a landing at least three feet long in the direction of travel shall intervene.

(o) All stairways shall have, on both sides, strong hand rails firmly secured about three feet high above the upper tread at each riser, except that stairs less than three feet wide need have a rail only on one side.

(p) Stairways over eight feet wide shall be provided with a central rail, not less than two inches in diameter, placed at a height of about three feet above the upper tread at each riser, firmly supported on metal standards. Stairways over twelve feet wide shall have such intermediate rails dividing the stairs into equal runs not over six feet wide. Where hand rails are fastened to walls, there shall be a minimum clearance of two inches between the rail and the wall, and the upper ends of wall hand rails shall be returned to wall or posts. At the head of each flight of stairs there shall be a post or standard at least six feet high, to which the intermediate rail or rails shall be fastened.

(q) Except as otherwise specified in this section, the provisions of Part 18 shall apply to exits from Group A buildings.

[†*As amended by Ord. 1943, ch. 2*]

***Sect. 306. Aisles and Seating.**— (a) In auditoriums, aisles having seats on both sides shall be not less than thirty inches in width at the end remote from an exit and shall be widened by two inches for each ten feet in length measured toward the exit. Aisles having seats on one side only shall be not less than twenty-four inches wide at the end remote from an exit, and shall be widened toward the exit by two inches for each ten feet in length. Side aisles serving more than one exit shall be of uniform width between exits and such width shall be not less than that required by this paragraph at a point midway between the extreme exits.

(b) Aisles shall be so arranged that not more than six seats shall intervene between any seat and the nearest aisle.

(c) There shall be no obstructions of any kind in an aisle. Aisles on the main floor and in balconies may be sloped or stepped. When sloped, the slope shall not exceed two inches vertical in ten inches horizontal. Where stepped the rise shall not exceed twenty-one inches in a horizontal distance of thirty-two inches. Stepped aisles shall not be construed to be stairways.

(d) The main floor of auditoriums shall have a cross-over aisle, either open or enclosed, at the rear extending from side to side of auditorium. Furthermore, if there are more than thirty-five rows of seats, there shall be in addition at least one cross-over aisle extending from side to side of the audi-

torium, and in no case shall there be more than thirty-five rows of seats between cross-over aisles. Balconies with more than five rows of seats shall have at least one cross-over aisle extending from side to side of balcony, and in no case shall there be more than twenty rows of seats between cross-over aisles. Cross aisles shall be not less than three feet wide in the clear and shall lead to exits that are easily accessible. Vomitories shall be considered entrances and exits.

(e) Seats shall be spaced not less than thirty-two inches except that seats with backs less than one inch thick may be spaced not less than thirty inches back to back. Seats in stepped balconies shall be spaced not less than thirty-two inches back to back. No seats shall be less than eighteen inches in width center to center. All seats shall be securely fastened to the floor, except as otherwise provided in this section.

(f) Seats in boxes accommodating less than twenty-five persons need not be fastened to the floor. Boxes accommodating twenty-five persons or more shall be considered balconies.

[**As amended by Ord. 1943, ch. 2*]

†**Sect. 307. Exit Lights.**— Over every exit doorway in any path of exit, on the inside, and over every opening to a fire escape, on the inside, there shall be an illuminated sign bearing the word "EXIT" or "FIRE ESCAPE", respectively, in letters not less than four inches high. Each sign shall be provided with two electric lamps.

[*†As amended by Ord. 1943, ch. 2*]

‡**Sect. 308. Light and Ventilation.**— (a) Dressing rooms, work shops, toilet rooms, auditoriums, foyers, and other public rooms shall be provided with light and ventilation by means of windows and skylights with an area not less than one eighth the floor area in each room, or they shall be provided with artificial light and a mechanically operated ventilating system. The mechanically operated ventilating system shall provide for four complete air changes per hour in rooms where required and in the auditorium shall supply at least fifteen cubic feet of fresh air per minute for each occupant thereof. If the velocity of the air entering the room exceeds five feet per second, the opening must be placed more than eight feet above the floor directly beneath. Adequate means shall be provided for the removal of foul air.

(b) Light shall be electric. Auditorium lights shall be on circuits separate from those of the stage and the remainder of the building, and shall be so arranged that they can be turned on from the stage and from at least one other approved point in the front of the house, with approved indicators to show when the lights are on.

(c) Lights in foyers, stairways, corridors and other paths of exit shall be on circuits separate from those of the stage, auditorium and the remainder of the building and shall be so arranged that they can be turned on from the stage and from at least one other approved point in the front of the house, with approved indicators to show when the lights are on.

(d) Exit sign lights and selected lights in foyers, auditoriums, stairways, corridors and other paths of exit sufficient to provide illumination for egress

of the audience in case of emergency shall be wired on separate circuits, and these lights, hereinafter referred to as emergency lights, shall be kept lighted when the building is occupied, except that outside balconies and fire escapes need not be lighted before sunset nor auditorium lights during a performance. The emergency lights may also include lights on switchboards, in projection rooms, in boiler rooms and at other critical points. Emergency lights shall be protected from possible physical damage.

(e) The emergency lights shall be provided with a second or emergency source of current and a transfer switch which will automatically disconnect the normal service and instantly connect the emergency service when the voltage of the normal service falls below fifty per cent of the nominal lamp voltage and which will also automatically disconnect the emergency service and instantly connect the normal service when the voltage of the latter is restored to eighty per cent of the nominal lamp voltage. The emergency source of current shall be either: —

(1) A separate feeder of the service company other than that from which the normal service is taken, or

(2) A separate feeder from a reliable generating plant independent of that from which the normal service is taken, or

(3) An approved storage battery, or

(4) Illuminating gas.

(f) Glass in lighting fixtures hung in auditoriums, lobbies or other public places shall be secured from falling by an approved method.

[‡*As amended by Ord. 1943, ch. 2 and 9*]

Sect. 309. Stage Ventilators, Group A Occupancy.— (a) There shall be one or more ventilators, constructed of metal or other non-combustible material, near the center and above the highest part of the stage. Such ventilator or ventilators shall be raised above the stage roof and shall have a total ventilating area at least equal to ten per cent of the floor space behind the proscenium wall, at the stage floor level, not separated from the stage by a two-hour separation.

(b) Doors or covers for ventilators shall open by gravity. Doors or covers shall be held closed and manually operated by means of cords extending to each side of the stage. These cords shall each be equipped with three fusible links one of which shall be placed in the ventilator above the main roof level and the other two at approved points not affected by sprinkler heads. Fusible links shall be of an approved type which will release at a temperature of one hundred and sixty degrees Fahrenheit. Each ventilator shall be opened and closed at least once before each performance.

(c) Glass, if used in ventilators, may be either plain or wired. If plain glass is used, a suitable wire netting shall be placed both above and below the glass.

Sect. 310. Proscenium.— (a) The stage portion shall be separated from the auditorium by not less than four-hour fire-resistive construction, as specified in Part 22. Such separation shall be known as the proscenium wall. This wall may be offset as desired, but such offset shall also be of not less

than four-hour fire-resistive construction. The proscenium wall shall not be finished or covered with combustible materials.

(b) The proscenium opening, the main opening for the viewing of performances, shall be provided with a proscenium curtain as follows: —

(1) The proscenium curtain shall be of incombustible and fire-resistive material. If of fabric, it shall be of asbestos cloth containing not over ten per cent by weight of cotton or other combustible fibre, shall be reinforced by wire and shall weigh not less than three pounds per square yard.

(2) Proscenium curtains of other materials than fabric, which are able to withstand a standard fire test, as specified in Part 22, for thirty minutes may be used with the approval of the commissioner.

(3) If the proscenium opening is not more than thirty-five feet wide the curtain shall have a rigid metal member at the top and at the bottom edge protected by the fabric on both stage and auditorium sides. If the proscenium opening is more than thirty-five feet wide the curtain shall have a rigid steel frame on all sides braced and constructed to the satisfaction of the commissioner and protected from fire on both stage and auditorium sides.

(4) The proscenium curtain shall extend into non-combustible grooves at the side a distance of at least twelve inches and the edges of the curtain shall be retained in the groove by means of a taut steel cable or by other approved means. The curtain shall overlap the top of the proscenium opening not less than eighteen inches. At the bottom edge the curtain shall be padded for a depth of at least four inches with flexible incombustible material.

(5) The proscenium curtain shall be so rigged, counter balanced, and operated that it can be quickly released to descend by gravity, and completely close the opening in case of fire. The releasing device and its location shall be approved by the commissioner.

(6) The proscenium curtain shall be raised and lowered at least once before every performance and shall be lowered at the close of every performance. The operation of the curtain by means of the releasing device shall be tested at intervals as required by the commissioner.

(c) The proscenium wall may have, in addition to the proscenium opening not more than two openings at the orchestra pit level and two openings at about the auditorium floor or stage level, none of which shall be more than twenty-five square feet in area. Each such opening shall be protected on each side of the wall by a Class A fire door as specified in Part 22. Ventilating ducts may pass through the proscenium wall, provided they are equipped with automatic-closing shutters of approved fire-resistive construction with fusible links.

Sect. 311. Stage Construction.— (a) The portion of the stage floor used in the working of scenery, traps or other mechanical apparatus, may be of Type III floor construction, and steel beams need not be protected against fire. This construction shall not extend beyond the proscenium wall or the proscenium curtain, and shall not exceed the width of the proscenium opening by more than three feet on each side. All other portions of the stage shall be of Type I construction as specified in Part 16. The room

or rooms under a stage of other than Type I construction shall not be used for storage or for any purpose other than the working of traps and mechanical apparatus necessary for a performance on the stage.

(b) Gridirons, fly galleries, and pin rails shall be constructed of incombustible materials, but fireproofing of metal shall not be required.

(c) A protecting hood of incombustible material shall be provided over and the full length of the stage switchboard. The switchboard shall be protected on the sides and back by a grille of three-sixteenths inch wire with not more than two-inch mesh, or by partitions of incombustible materials having a one-hour fire-resistive rating, and on the front by a railing not less than three feet high.

Sect. 312. Dressing Rooms and Workshops.— The dressing rooms, workshops and storerooms shall be separated from the stage by a two-hour separation as specified in Part 13.

Sect. 313. Fire-Extinguishing Apparatus.— (a) Automatic sprinklers shall be provided throughout, except in auditoriums, foyers, lounges, entrances, exits and projection rooms.

(b) The proscenium opening shall be equipped with an effective water curtain by means either of automatic sprinkler heads of suitable design, or open heads controlled by either of two valves on the stage, one on each side of the proscenium opening.

(c) A portable fire extinguisher or extinguishers of approved type shall be provided on the outside of each projection room near the door or doors.

(d) Portable extinguishers, not less than one for every two thousand square feet of floor area, shall be provided throughout except in entrances and exits.

(e) First aid hose stations shall be provided throughout, except in projection rooms, auditoriums, foyers, lounges, entrances, exits and other rooms used by the public. There shall be one station each side of the stage.

(f) Fire department standpipes shall be provided in buildings more than seventy feet high.

Sect. 314. Projection Room.— The size, construction, arrangement and equipment of a projection room shall conform to the requirements of sections seventy-two to eighty-eight, inclusive, of chapter one hundred and forty-three of the General Laws, and to the regulations established thereunder by the commissioner of public safety of the commonwealth of Massachusetts.

PART 4.

SPECIAL REQUIREMENTS FOR GROUP B OCCUPANCY: HALLS.

***Section 401. Group B Occupancies: Type, Height, Area.— (a)** Group B shall include places where persons may assemble for such and similar purposes as are indicated in the following list of categories, where the main floor exceeds nine hundred square feet in area or where the total floor area, including a balcony, exceeds one thousand square feet.

(1) Churches in the commonly accepted sense of religious societies.

(2) Rooms and halls where people may engage in any form of dancing.

(3) Auditoriums, Entertainment and Exhibition Halls without gridiron equipped stages as defined in Group A.

(4) Moving picture theatres without gridiron equipped stages as defined in Group A.

(5) Gymnasiums and sports events halls.

(6) Meeting and gathering places of fraternal, social, civic, and philanthropic organizations.

(b) Buildings or parts of buildings classified for occupancy in Group B, and of the several types of construction, shall not exceed in height and area of units of occupancy the following limits:—

Type of Construction.	Stories.	Maximum Area of Unit (Square Feet).
I	Not hereby limited.	Not hereby limited.
II	4	18,000
	1	Not hereby limited. Maximum distance in path of exit, 175 feet.
III	4	17,000
	1	Not hereby limited. Maximum distance in path of exit, 150 feet.
IV	3	12,000
	1	Not hereby limited. No structure of combustible material to support seats or aisles to be superimposed on the floor construction. Maximum distance in path of exit, 100 feet.
V	Not allowed.	Not allowed.
VI	1	5,000

The maximum area may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The first floor of all buildings more than two stories in height shall be of Type I construction. No assembly hall of floor area exceeding thirty-six hundred square feet and no group of assembly halls of aggregate floor area exceeding forty-eight hundred square feet shall be above the first story unless the building is of Type I or Type II construction.

(d) The maximum area provided in this section may be increased fifty per cent if the entire floor area is protected by automatic sprinklers.

[**As amended by Ord. 1943, ch. 2*]

Sect. 402. Separation of Occupancies.— Group B occupancies shall be separated from other occupancies, and fire divisions of Group B occupancy shall be separated from adjoining fire divisions as specified in Part 13.

†Sect. 403. Exterior Walls.—(a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings, except that openings in such walls at the ends of courts shall be allowed when protected by fire windows or Class B fire doors. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by fire windows or Class B fire doors.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by fire windows or Class B fire doors.

(c) The commissioner may waive the requirements of this section, for the protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds to comply with the said requirements on demand of the commissioner.

[*†As amended by Ord. 1943, ch. 2*]

Sect. 404. Enclosure of Vertical Openings.—(a) Main stair or ramp exits from only the second story need not be enclosed. Stairways or ramps which extend only from a balcony in a hall to the main floor level need not be enclosed. Other stairways and ramps which pierce only one floor shall be enclosed in the story above or below but such stairways which serve as required exits from one story shall be enclosed in the other. Other stairways and ramps shall be enclosed in all stories in which they occur.

(b) Elevator shafts, ventilation shafts and other vertical openings except stairways and ramps, shall be enclosed.

‡Sect. 405. Exits and Entrances.— (a) Group B buildings shall front upon a public street not less than twenty feet wide or upon an open area not less than twenty feet wide leading to a public street. In this front shall be located the main entrance of the building. The main entrance or entrances, which may also serve as exits, shall have in the aggregate twenty inches of clear width for each one hundred persons to and including one thousand per-

sons, with an additional ten inches for each additional one hundred persons to and including one thousand additional persons, and an additional five inches for each additional one hundred persons over two thousand persons. In a one story or two story building the width of entrance shall be based upon the total seating capacity of the halls served by it. In a building of three or more stories the width of entrance shall be based upon the maximum total seating capacity of the halls served by it which are contained in any two stories. (See definition of "seating capacity.")

(b) Adjacent to the main floor and to each balcony, if any, of an assembly hall and between the hall and its main entrance in the path of normal entrance and egress, except in the first story, there shall be a foyer, consisting of a lobby, corridor or passageway, one or more, the aggregate floor area of which shall be at least equal to one square foot for each seat in the seating capacity of the hall or balcony so served; provided, that one such area may serve two or more halls or balconies on the same floor level if large enough for the largest two halls so served. A hall, with a balcony seating not more than one hundred and fifty persons, may have a common foyer. A foyer shall have a width of at least ten inches for each one hundred seats in the seating capacity of the largest two halls served by it.

(c) Assembly halls having a seating capacity of fifteen hundred or less shall have exits with an aggregate width of at least twenty-four inches for each one hundred seats thereof and no exit shall be less than three feet wide. Halls having a seating capacity of five hundred or less shall have at least two remote exits. Halls having a seating capacity of more than five hundred, but not more than eight hundred, shall have at least three remote exits. Halls having a seating capacity of more than eight hundred, but not more than one thousand, shall have at least four remote exits of which two shall be at least five feet wide. Halls having a seating capacity exceeding one thousand shall have at least four remote exits five feet wide. Every assembly hall shall have at least two remote and independent paths of exit. Halls having a seating capacity of more than fifteen hundred shall have exits meeting the requirements for normal and emergency exits from the auditoriums of Group A buildings. Every balcony seating more than twenty-five persons shall have two remote exits.

(d) At least one exit from every hall or balcony shall lead into the foyer thereof and all such exits may lead into the foyer if it has two remote exits. Exterior stairways and ramps shall not serve as required exits of Group B buildings except the emergency exits required for halls seating more than fifteen hundred. Exits from foyers and all paths of exit from doorways from assembly halls shall be at least forty-four inches wide and shall have an aggregate width at least equal to twenty inches for each one hundred seats in the seating capacity of the halls of any one story served by them. No point on the main or balcony floor of an assembly hall shall be further from the nearest exit from the story than one hundred and fifty feet along a path of exit.

(e) Enclosed stairways or ramp exits shall discharge directly through an exit from the building or through an enclosed corridor leading to an exit from the building.

(f) Doorways from a room leading into a stair enclosure shall have single acting, self-closing doors opening in the direction of any path of exit.

If doors in exit doorways in any path of exit have latches, such latches shall be panic bolts or similar approved devices, of non-corrodible metal.

(g) Stairs shall have a handrail on each side. The upper ends of handrails shall return to the wall or to a post.

(h) Except as otherwise specified in this section the provisions of Part 18 shall apply to exits from Group B buildings.

[‡ *As amended by Ord. 1943, ch. 2*]

***Sect. 406. Aisles and Seating.**— (a) Aisles having seats on both sides shall be not less than thirty inches in width at the end remote from an exit and shall be widened by two inches for each ten feet in length measured toward the exit. Aisles having seats on one side only shall be not less than twenty-four inches wide at the end remote from an exit, and shall be widened toward the exit by two inches for each ten feet in length. Side aisles serving more than one exit shall be of uniform width between exits and such width shall be not less than that required by this paragraph at a point midway between the extreme exits.

(b) Aisles shall be so arranged that not more than six seats shall intervene between any seat and the nearest aisle

(c) There shall be no obstructions of any kind in an aisle. Aisles on the main floor and in balconies may be sloped or stepped. When sloped, the slope shall not exceed two inches vertical in ten inches horizontal. When stepped, the rise shall not exceed twenty-one inches in a horizontal distance of thirty-two inches. Stepped aisles shall not be construed to be stairways.

(d) The main floor of auditoriums shall have a cross-over aisle, either open or enclosed, at the rear extending from side to side of auditorium. Furthermore, if there are more than thirty-five rows of seats there shall be in addition at least one cross-over aisle extending from side to side of the auditorium, and in no case shall there be more than thirty-five rows of seats between cross-over aisles. Balconies with more than five rows of seats shall have at least one cross-over aisle extending from side to side of balcony, and in no case shall there be more than twenty rows of seats between cross-over aisles. Cross aisles shall be not less than three feet wide in the clear and shall lead to exits that are easily accessible. Vomitories shall be considered extrances and exits.

(e) Seats shall be spaced not less than thirty-two inches except that fixed seats with backs less than one inch thick may be spaced not less than thirty inches back to back. Seats in stepped balconies shall be spaced not less than thirty-two inches back to back. No seats shall be less than eighteen inches in width center to center.

(f) In a hall or balcony seating more than one hundred and fifty persons, seats shall either be fastened to the floor or approved means shall be provided so that the relative position of seats shall be maintained. In smaller halls or balconies, unless the seats are so secured, the aisles shall be four inches wider than as provided in paragraph (a) of this section.

[**As amended by Ord. 1943, ch. 2*]

*Sect. 407. **Exit Lights.**— Over every exit doorway in any path of exit on the inside, there shall be an illuminated sign bearing the word "EXIT" in letters not less than four inches high. Each sign shall be provided with two electric lamps.

[**As amended by Ord. 1943, ch. 2*]

†Sect. 408. **Light and Ventilation.**— (a) Assembly halls, foyers, toilet rooms and other public rooms shall be provided with light and ventilation by means of windows or skylights with an aggregate area not less than one eighth the floor area in each room, or they shall be provided with artificial light and a mechanically operated ventilating system. The mechanically operated ventilating system shall provide for four complete changes of air per hour, and in assembly halls shall supply at least fifteen cubic feet of fresh air per minute for each occupant thereof. If the velocity of the air entering the rooms exceeds five feet per second, the opening must be placed more than eight feet above the floor directly beneath. Adequate means shall be provided for the removal of foul air.

(b) Registers or ventilating ducts for supplying air to or exhausting air from stages shall be equipped with automatic-closing shutters with fusible links.

(c) Lights for stages shall be on circuits separate from the lights of the remainder of the building. Lights in corridors, stairways, and other parts of exits shall be suitably protected.

(d) In an assembly hall having a seating capacity in excess of eight hundred the exit sign lights and selected lamps in foyers, auditoriums, stairways, corridors and other paths of exit therefrom sufficient to provide illumination for egress in case of emergency shall be wired on a separate emergency circuit with a second source of current as provided for in Group A occupancy. Exit sign lights shall be kept lighted when the hall is occupied, and other emergency lights, except auditorium lights, when the hall is occupied except before sunset in rooms, corridors and stairways sufficiently lighted by windows.

(e) The emergency lights shall be provided with a second or emergency source of current and a transfer switch which will automatically disconnect the normal service and instantly connect the emergency service when the voltage of the normal service falls below fifty per cent of the nominal lamp voltage and which will also automatically disconnect the emergency service and instantly connect the normal service when the voltage of the latter is restored to eighty per cent of the nominal lamp voltage. The emergency source of current shall be either:—

(1) A separate feeder of the service company other than that from which the normal service is taken, or

(2) A separate feeder from a reliable generating plant independent of that from which the normal service is taken, or

(3) An approved storage battery, or

(4) Illuminating gas.

[†*As amended by Ord. 1943, ch. 2 and 9*]

Sect. 409. Stage and Proscenium.— (a) Where a stage or platform is without provisions for scenery, no separation from the auditorium shall be required, and such stage or platform may be of the same type of construction as the auditorium floor; or it may be constructed of wood, if the auditorium floor extends under the full area of such stage or platform.

(b) Where a stage has provisions for standing scenery only, such stage shall be separated from the auditorium by a proscenium wall of not less than two-hour fire-resistive construction. Each opening through this wall other than the proscenium opening, shall not exceed twenty-five square feet in area, and shall be protected by a Class A fire door. Where such stage exceeds fifteen feet in depth, or where the proscenium opening exceeds twenty-five feet in width or twelve feet in height, the proscenium opening shall be provided with a proscenium curtain as specified for theatres in Part 3. Where such stage is less than fifteen feet in depth, and the proscenium opening is less than twenty-five feet in width and twelve feet in height, the proscenium curtain shall be either of asbestos fabric or of cotton or other fabric flame-proofed by approved chemical process.

Sect. 410. Dressing Rooms, Workshops and Boiler Rooms.— Dressing rooms, workshops and store rooms near the stage shall be separated therefrom by a two-hour separation as defined in Part 13. Every boiler room or room containing a heating plant shall be separated from the rest of the building by a two-hour separation.

***Sect. 411. Fire Extinguishing Apparatus.**— (a) Cellars and basements, stages with proscenium walls, accessible areas — other than the Assembly Hall, entrances and exits, and projection rooms shall be equipped with Automatic Sprinklers. Attics, the space under stages and other such paces, if available for storage, shall be equipped with Automatic Sprinklers.

(b) In buildings where Group B occupancy is located above occupancy of other grouping or groupings, the areas of the other grouping or groupings shall be equipped with Automatic Sprinklers.

(c) In every Assembly Hall where stage shall have a proscenium wall as required by Section 409 (b), the proscenium opening shall be equipped with a water curtain as specified in Part 3.

(d) A portable fire extinguisher of approved type shall be provided outside of every projection room near each projection room door.

(e) In buildings more than two stories high, either portable extinguishers, not less than one for every two thousand square feet of floor area, or first aid standpipes, shall be provided in spaces other than projection rooms, but first aid standpipes shall not be provided in assembly halls, corridors, foyers, exits and other rooms used by persons assembled in such halls.

(f) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

[**As amended by Ord. 1943, ch. 2*]

†Sect. 412. Projection Room.— A projection room shall have a floor of incombustible material supported on a concrete base not less than three

inches in total thickness which may be supported by a floor of the same type of construction as that of the building, or of other materials having equivalent fire-resistance. A projection room shall have walls and ceiling of not less than one-hour fire-resistive construction of incombustible materials. In other respects a projection room shall conform to the requirements of sections seventy-two to eighty-eight, inclusive, of chapter one hundred and forty-three of the General Laws, and to the regulations established thereunder by the commissioner of public safety of the commonwealth of Massachusetts.

[†*As amended by Ord. 1943, ch. 2*]

PART 5.

SPECIAL REQUIREMENTS FOR GROUP C OCCUPANCY: SCHOOLS.

*Section 501. Group C Occupancy: Type, Area.— (a) Group C shall include every post-code building used wholly or in part as a school.

(b) Buildings or parts of buildings classified for occupancy in Group C shall be limited as to type of construction, height and area of units, as follows:—

Type of Construction.	Stories.	Maximum Area of Unit (Square Feet).
I....................	Not hereby limited.	Not hereby limited.
II....................	4	18,000
	1	24,000
III....................	2	17,000
	1	20,000
IV....................	2	12,000
	1	18,000
V....................	Not allowed.	Not allowed.
VI....................	1	5,000

The maximum area may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The maximum area provided in this section may be increased fifty per cent if the entire floor area is protected by automatic sprinklers.

(d) Assembly halls with seating capacity of more than one hundred and fifty persons shall conform with the requirements of Part 4 and, in addition, the width of exits shall be computed in multiples of twenty inches for each one hundred seats.

(e) Every Group C post-code building in the first or second fire zone shall be of Type I or Type II construction.

(f) When school usage involves special conditions such as the use of hazardous, highly inflammable or explosive materials or liquids or any other special occupancy that is a hazard, they shall also conform to the special requirements of that occupancy or hazard.

(g) Pre-code buildings or parts of buildings involving a change of occupancy to Group C, whether or not altered or enlarged shall conform to the general requirements of this section as they shall be interpreted by the commissioner as delineated in Section 107, paragraph (e), and they shall be limited as to type of construction, (number of stories,) and area of units as follows:

Type of Construction.	Stories.	Maximum Area of Unit (sq. ft.)
I..................	Not hereby limited.	Not hereby limited.
II..................	4	18,000
	1	24,000
III..................	5	5,000
IV..................	5	5,000
V..................	Not allowed.	
VI..................	2	4,000

[**As amended by Ord. 1943, ch. 3*]

Sect. 502. Separation of Occupancies.— Group C occupancies shall be separated from other occupancies, and fire division of Group C occupancy shall be separated from adjoining fire divisions as specified in Part 13.

†**Sect. 503. Exterior Walls.**— (a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

[†*As amended by Ord. 1943. ch. 3*]

‡**Sect. 504. Enclosure of Vertical Openings.**— (a) Elevator shafts, ventilating shafts, dust chutes and other vertical openings shall be enclosed.

(b) Stairways and ramps which pierce only one floor shall be enclosed in the story above or below, but such stairways or ramps which serve as required

exits from one story shall be enclosed in the other story. Other stairways and ramps shall be enclosed in all stories in which they occur.

[‡*As amended by Ord. 1943, ch. 3*]

*Sect. 505. **Exits.**— (a) All rooms used for the instruction of pupils shall have at least two means of egress; one of which shall open into a corridor, stairway, ramp or other egress enclosure; the other shall lead to another separate corridor, stairway, ramp or other egress enclosure through intervening rooms and intercommunicating doors. The width of exit doors shall be not less than thirty-six inches nor less than twenty inches for each one hundred occupants thereof.

(b) Corridors shall have uniform width between exits and shall have a clear exit-width not less than six feet, nor less than twenty inches for each one hundred persons or fraction thereof allotted to it as a path of exit; provided, that the exit-width of a corridor shall not be required to exceed ten feet. If classroom doors on one or both sides of a corridor project into it when in open position, the width of the corridor shall be increased over its required exit-width by one half the sum of such projections. If lockers are installed in the walls of corridors on one or both sides, the width of the corridor shall be increased over its required exit-width by eighteen inches for each side on which lockers are installed. No obstruction shall be placed in corridors except that the drip of a recessed drinking fountain or a radiator may project into a corridor. If a radiator less than six feet six inches above the floor is placed in a path of exit and is not fully recessed, the width of the corridor shall be measured from the face of the radiator.

(c) Each corridor shall have at least two remote exits which shall be exits from the story as specified in Part 18. Such exits shall be so located that every doorway from a room for pupils to a corridor shall be not more than seventy feet from an exit from the corridor. The persons in each room having an exit to a corridor shall be allotted to a path of exit through the corridor to the nearest exit therefrom for the purpose of computing the width of corridors and their exits; provided, that if the mid-length point of a corridor between its exits lies in an exit from a room or between two exits from a room, the persons in such room may be allotted to either exit from the corridor. The width of every exit from a corridor shall be not less than forty inches, nor less than twenty inches for each one hundred persons or fraction thereof allotted to it.

(d) Each story of a Group C building shall have at least two remote exits. The width of stairs and ramps and of exits from them shall be not less than forty inches nor less than twenty inches for each one hundred persons or fraction thereof allotted to them and shall be based upon the largest number of persons from any one story whom they serve as exits. If doors in exit doorways more than four feet wide have latches, such latches shall be panic bolts or similar devices of non-corrodible material.

(e) No intake for a dust or waste paper chute shall open directly upon a corridor or enclosed exit, but may open in a closet off a corridor.

(f) All stairs shall have a handrail on each side. Stairs eighty inches or more in width shall have one or more intermediate rails dividing the stairs

into widths less than eighty inches but not less than forty inches; provided, that in calculating the capacity as an exit of a stair so divided, each division shall be considered an exit. The upper ends of handrails shall be returned to the wall or shall so terminate at a post as not to leave a free or projecting end.

(g) Stair landings shall have a width at least equal to that of the stairs. No run of stairs shall have more than fifteen nor less than three risers. The rise shall not exceed seven and one half inches nor shall the tread be less than ten inches. Winders shall not be permitted.

[**As amended by Ord. 1943, ch. 3*]

Sect. 506. Aisles and Seating.— (a) Classrooms with fixed seats shall have aisles at least thirty inches wide next to the windows and at least thirty-six inches wide on other sides, and intermediate aisles at least sixteen inches wide.

(b) Unless definitely fixed on the plans the normal seating capacity of classrooms shall be determined by dividing the floor area of each room as follows: —

Elementary Schools	by 15 square feet
Intermediate Schools	by 17 square feet
High Schools and Colleges	by 19 square feet

†**Sect. 507. Light.**— (a) Rooms used by pupils for study and class work shall have outside windows with a total sash area not less than one fifth the floor area of each such room. The windows shall preferably be on the long side of a room. The clear height of a room shall be not less than ten feet. No room shall be used for class work where an exterior wall outside and opposite the required windows shall extend above a line from the window sills at thirty degrees above the horizontal unless such wall is at least sixty feet from the windows. The possibility of a building on an adjoining lot shall be provided for.

(b) Corridors, stairways and other exits shall have artificial illumination which, if electric, shall be on circuits and control separate from other lighting in the building.

[*†As amended by Ord. 1943, ch. 3 and Ord. 1955, ch. 1*]

Sect. 508. Ventilation and Heating.— (a) In all rooms used by pupils for school purposes shall be installed a positive system of ventilation that will supply fresh air, heated when necessary, and adequately remove the foul air. In class, recitation and study rooms there shall be provided at least six complete air changes per hour but not less than twenty cubic feet of fresh air per minute per pupil normally seated, and in assembly rooms, gymnasiums, lunch rooms and vocational rooms at least four complete changes of air per hour but not less than fifteen cubic feet per minute per pupil for whom seating or work space is provided. In toilets, shower and locker rooms at least eight complete air changes per hour shall be provided and these rooms shall be ventilated by an exhaust system.

(b) The heating and ventilating system shall be capable of maintaining, when the outside temperature is zero, in gymnasiums and toilets a temperature

of sixty degrees, in shower and locker rooms appurtenant to gymnasiums seventy-five degrees, and in other rooms used by pupils or teachers seventy degrees, all by Fahrenheit scale.

Sect. 509. Fire-Extinguishing Apparatus.— (a) Cellars and basements, except those portions used for classes, shall be equipped with automatic sprinklers. Mechanical trade shops, storage rooms and attics available for storage shall have automatic sprinklers where required by the commissioner.

(b) A portable fire-extinguisher of approved type shall be provided outside every projection room near the door.

(c) In buildings more than two stories high, either portable fire-extinguishers, not less than one for every thirty-five hundred square feet of floor area and not less than one in each story, or first aid standpipes shall be provided, but first aid standpipes shall not be provided in assembly halls or in exits therefrom.

(d) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

Sect. 510. Special Requirements.— Every boiler room shall be separated from the remainder of the building by a two-hour separation as specified in Part 13.

Sect. 511. Toilet Accommodations.—(a) Adequate toilets shall be provided for pupils, with fixtures in accordance with the following table:—

Number of Pupils of Either Sex.	Girls.	Boys.	
	Water Closets.	Water Closets.	Urinals.
50	4	3	4
100	6	4	6
150	9	6	8
200	12	8	10
250	14	9	12
300	16	10	14
350	18	11	16
400	20	12	18
450	22	13	20
500	24	14	22
1,000	43	25	40
1,500	61	36	56

(b) For intermediate numbers of pupils, fixtures shall be provided by interpolation in the table and for numbers in excess of fifteen hundred at the rate provided for fifteen hundred.

(c) Separate toilets shall be provided for the teachers and for the janitors.

PART 6.

SPECIAL REQUIREMENTS FOR GROUP D OCCUPANCY: HOSPITALS AND DETENTION BUILDINGS.

*Section 601. **Group D Occupancy: Type, Height, Area.**—(a Group D shall include such occupancies as —

Division 1. Jails, prisons, reformatories, houses of correction, asylums for the insane or feeble minded, the parts of police stations wherein more than ten persons may be detained, and similar buildings.

Division 2. Hospitals, sanitariums, orphanages, nurseries, homes for the aged and similar buildings, with sleeping accommodations for ten or more persons.

(b) Buildings or parts of buildings classified for occupancy in Group D shall be limited as to type of construction, height and area of units, as follows:—

Type of Construction.	Stories.	Maximum Area of Unit (Square Feet)
I....................	Not hereby limited.	Not hereby limited.
II....................	4	17,000
	1	20,000
III....................	2	12,000
	1	18,000
IV....................	2	10,000
	1	15,000
V....................	Not allowed.	Not allowed.
VI....................	1	2,500

The maximum area may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) Division 1 buildings of Group D shall be of Type I construction throughout. The ceilings and partitions of Division 2 buildings of Group D

more than one story in height shall be of not less than one-hour fire-resistive construction and the first floor of such buildings more than two stories in height shall be of Type I construction.

(d) The provisions of this section and of Part 16 shall not be held to prohibit cell block mezzanine floor construction of unprotected metal without limitation as to number and area of such floors provided the entire cell block construction is of incombustible materials.

[**As amended by Ord. 1943, ch. 3*]

Sect. 602. Separation of Occupancies.— Group D occupancies shall be separated from other occupancies, and fire divisions of Group D occupancy shall be separated from adjoining fire divisions as specified in Part 13.

Sect. 603. Exterior Walls.—(a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings, except that openings in such walls at the ends of courts shall be allowed when protected by Class B fire doors or fire windows. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

Sect. 604. Enclosure of Vertical Openings.—(a) Elevator shafts, ventilating shafts and other vertical openings, except stairways and ramps, shall be enclosed.

(b) Stairways and ramps which pierce only one floor shall be enclosed in the story above or below but such a stairway or ramp which serves as required exit from one story shall be enclosed in the other story. Other stairways and ramps shall be enclosed in all stories in which they occur.

(c) This section and Part 15 shall not be held to require enclosure of mezzanine floors in Group D buildings nor of vertical openings in such floors, nor of cell block floors if such cell blocks are constructed entirely of incombustible materials.

†**Sect. 605. Exits.**—(a) Every portion of a building shall be provided with exits as specified in Part 18.

(b) In buildings of Division 2 exits from a story, as specified in Part 18, shall be so located that no bed shall be more than seventy feet distant from at least one such exit measured along the path of exit.

(c) In buildings of Division 2 exit doorways from patients' rooms shall be not less than forty-two inches wide. In such buildings corridors, stairways, ramps, doorways in stair or ramp enclosures and doorways from the building, which serve as required exits, shall be not less than sixty inches wide. In such stairways the tread shall not be less than eleven inches nor the rise more than six and one half inches; stair landings at turns shall be not less than sixty inches wide.

(d) Except in places of detention, exit doors shall not be fastened against egress except by self-releasing latches, panic-bolts or similar devices which can readily be opened from the inside at all times without the use of keys or any special knowledge or effort. Revolving doors shall not be installed in required exit doorways from buildings of Group D occupancy.

[†*As amended by Ord. 1943, ch. 3*]

‡**Sect. 606. Light and Ventilation.**— Rooms ordinarily occupied by human beings shall be provided with light by means of windows in exterior walls or skylights in roofs, the area of which shall not be less than one-eighth of the floor area, and the same shall be ventilated by windows in exterior walls the area of which when open shall not be less than one-sixteenth of the floor area of the room, or by mechanically operated ventilating system supplying at least fifteen cubic feet of fresh air per minute per occupant or four complete changes of air each hour, whichever is greater. Rooms accommodating a bed shall be provided with light and ventilation by means of windows in exterior walls, the area of which shall not be less than one-eighth of the floor area for light and when opened for ventilation not less than one-sixteenth of the floor area.

[‡*As amended by Ord. 1943, ch. 3*]

Sect. 607. Fire-Extinguishing Apparatus.—(a) All cellars, basements and shafts shall be protected by automatic sprinklers. Store rooms, kitchens and utility rooms in buildings of other than Type I or Type II construction shall be protected by automatic sprinklers.

(b) In all buildings either portable fire extinguishers, not less than one for every twenty-five hundred square feet of floor area and at least one in each story, or first aid standpipes shall be provided.

(c) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

Sect. 608. Special Requirements.— (a) Every gas service shall have a shut-off easily accessible from the outside and conspicuously marked.

(b) Every boiler room or room containing heating apparatus shall be separated from the rest of the building with a three-hour fire separation, as specified in Part 13.

Sect. 609. Exceptions.— No requirement of this chapter shall be so construed as to prohibit the construction of cells in jails or prevent the use of locks or safety devices in buildings where it is necessary forcibly to restrain the inmates.

***Sect. 610. Emergency Lights.**— There shall be emergency lights and they shall be provided with a second or emergency source of current and a transfer switch which will automatically disconnect the normal service and instantly connect the emergency service when the voltage of the normal service falls below fifty per cent of the nominal lamp voltage and which will also automatically disconnect the emergency service and instantly connect the normal service when the voltage of the latter is restored to eighty per cent of the nominal lamp voltage. The emergency source of current shall be either: —

(1) A separate feeder of the service company other than that from which the normal service is taken, or

(2) A separate feeder from a reliable generating plant independent of that from which the normal service is taken, or

(3) An approved storage battery, or

(4) Illuminating gas.

[**As amended by Ord. 1943, ch. 3 and 9*]

PART 7.

SPECIAL REQUIREMENTS FOR GROUP E OCCUPANCY: COMMERCIAL BUILDINGS OF HAZARDOUS OCCUPANCY.

SECTION

***Section 701. Group E Occupancy: Type, Height, Area.**—(a) Group E shall include such occupancies as —

Division 1. Planing mills, box factories, wood working plants, mattress factories, paint shops and dry cleaning plants.

Division 2. Buildings for the storage of hazardous, highly flammable or explosive material.

(b) Buildings or parts of buildings classified for occupancy in Group E shall be limited as to type of construction, height and area of units, as follows: —

Type of Construction.	Height Stories.	Maximum Area of Unit in Square Feet. Accessibility from Outside Walls.			
		25% or less.	More than 25% to 50%.	More than 50% to 75%.	More than 75%.
I	15	10,000	15,000	20,000	25,000
II	4	8,000	10,000	12,000	14,000
III	4	8,000	10,000	12,000	14,000
IV	3	4,000	6,000	8,000	10,000
	1	6,000	8,000	10,000	12,000
V	1	6,000	8,000	10,000	12,000
VI	1	3,000	4,000	5,000	6,000

The maximum area of Type IV units may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The limitations upon area of the foregoing table shall not apply to buildings one story high of Division 1, of Type I construction, the units of which may have areas not in excess of fifteen thousand, twenty thousand and twenty-five thousand square feet, if accessible from one, two or three sides, respectively.

[**As amended by Ord. 1943, ch. 3*]

Sect. 702. Separation of Occupancies.— Group E occupancies shall be separated from other occupancies, and fire divisions of Group E occupancy shall be separated from adjoining fire divisions as specified in Part 13. Two tenants shall be separated by partitions of at least one-hour and, in a basement, at least two-hour fire-resistive rating.

Sect. 703. Exterior Walls.— (a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings, except that openings in such walls at the ends of courts shall be allowed when protected by Class B fire doors or fire windows. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The Commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

***Sect. 704. Enclosure of Vertical Openings.**— (a) Elevator shafts, ventilating shafts and other vertical openings except stairways and ramps shall be enclosed.

(b) Mezzanine floors shall be enclosed when otherwise the total floor area in one story exposed to a single fire would exceed the maximum area of unit specified in section seven hundred and one. Vertical openings in enclosed mezzazine floors shall be enclosed as herein provided for other floors.

(c) Stairways and ramps which pierce only one floor, shall be enclosed in the story above or below but such stairways or ramps, which serve as required exits from one story, shall be enclosed in the other story. Other stairways shall be enclosed in all stories in which they occur.

[**As amended by Ord. 1943, ch. 3*]

Sect. 705. Exits.— (a) Every portion of a building shall be provided with exits as specified in Part 18.

(b) Exits from every story shall be so located that no point within the story shall be further than one hundred feet from the nearest exit.

(c) Doorways serving as exits from rooms into a stair or ramp enclosures shall have one-way swinging self-closing doors opening in the direction of egress.

†Sect. 706. Light and Ventilation.— Rooms used by human beings shall be provided with light and ventilation by means of windows or skylights or with artificial light and a ventilating system.

[*†As amended by Ord. 1943, ch. 3*]

***Sect. 707. Fire-Extinguishing Apparatus.**— (a) Automatic sprinklers or other adequate fire-extinguishing apparatus as approved by the commissioner shall be installed in the following locations:—

(1) Throughout every unit of occupancy higher than two stories or having an aggregate floor area greater than ten thousand square feet.

(2) In cellars and basements of which the floor area is more than fifteen hundred square feet.

(3) Throughout a building which is occupied wholly or in part as a planing mill, box factory, or other wood working establishment, in which more than two power-operated wood working machines, other than saws, are used.

(4) Throughout a building which is occupied wholly or in part as a mattress factory or used to manufacture, assemble or renovate mattresses or stuffed furniture using cotton, silk floss, mohair or other like material for packing or stuffing.

(5) In a building used as a film exchange, or for the manufacture or storage of nitro-cellulose pyroxylin products.

(b) Portable fire-extinguishers, not less than one for every two thousand square feet of floor area and at least one in each story, or first aid standpipes shall be provided, except as required by chapter one hundred and forty-eight of the General Laws and regulations issued thereunder.

(c) Fire department standpipes and first aid standpipes shall be provided in every building more than seventy feet high.

[**As amended by Ord. 1943, ch. 3*]

†Sect. 708. Special Hazards.— (a) Neither apparatus having an open flame nor a heater with an enclosed flame shall be installed or operated in a dry cleaning establishment or place where volatile flammable liquids are used or stored, unless approved by the state fire marshal.

(b) Rooms in which volatile flammable liquids are used or stored shall be enclosed with partitions of not less than one-hour fire-resistive construction as specified in Part 22. Doorways in such partitions shall have Class C fire doors so equipped as to close automatically in case of fire.

(c) In a dry cleaning establishment each machine which uses a volatile flammable liquid shall have an adequate steam line directly connected to it, so arranged as automatically to fill the machine with steam in case of fire or explosion therein.

(d) In dry cleaning establishments and other buildings in which volatile flammable liquids are used, sold or stored;

(1) Type VI construction shall not be used;

(2) Type IV construction shall not be used more than two stories in height or over six hundred square feet in area.

(e) Rooms in which paint, petroleum or other flammable liquids are used or stored otherwise than in unopened containers shall have non-absorbent, incombustible floor finish.

[*†As amended by Ord. 1943, ch. 3*]

PART 8.

SPECIAL REQUIREMENTS FOR GROUP F OCCUPANCY: OFFICES AND COMMERCIAL BUILDINGS.

*Section 801. Group F Occupancy: Type, Height, Area.— (a) Group F shall include such occupancies as —

Division 1. Office buildings, restaurants, police and fire stations, museums and libraries.

Division 2. Wholesale and retail stores, printing plants, factories and work shops using materials not highly flammable.

Division 3. Buildings for the storage or sale of goods not highly flammable, stables and buildings not on wharves for the storing or handling of transient freight.

Division 4. Wharf buildings for the storage or handling of transient freight.

Division 5. Garages of more than six cars capacity and hangars.

(b) Buildings or parts of buildings classified for occupancy in Group F except those in Division 4 thereof, shall be limited as to type of construction, height and area of units, as follows: —

Type of Construction	Height in Stories.	Maximum Area of Unit in Square Feet Accessible From		
		Minimum within block Less than 30%.	30% and less than 50% of perimeter.	More than 50% of perimeter.
I............		Not hereby limited.		
II...........	8	10,000	15,000	40,000
	1	15,000	15,000	Not hereby limited.
III..........	4	10,000	15,000	20,000
	1	15,000	15,000	Not hereby limited.
IV...........	3	10,000	15,000	20,000
	1	15,000	15,000	Not hereby limited.
V............	2	6,000	8,000	10,000
	1	6,000	8,000	20,000
VI...........	2	3,000	5,000	10,000

NOTE.— Where areas in 1 story buildings are not hereby limited, the maximum distance from any point to an exit from the building shall be 175 lineal feet.

In garages over six cars Type VI shall not be allowed.

The maximum area of Type IV units may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The portions of police stations in which not more than ten persons may be detained shall be constructed of incombustible materials and shall be separated from the remainder of the building, if of combustible materials, by a two-hour fire-resistive separation.

(d) Buildings on wharves, used for storage other than that which is incidental to handling water-borne freight, or used for manufacturing or any purpose other than such handling, shall be classified in an occupancy group according to such use, disregarding their location on wharves. Buildings on wharves of pile or other open construction over water, or of filled construction behind retaining walls or bulkheads, beside docks wherein vessels may be moored, used for handling, namely for assembling, loading, discharging and sorting water-borne freight, or for passengers, and of the several types of construction shall not exceed in height and area of units of occupancy the following limits: —

Type of Construction.	Stories.	Maximum Area of Unit (Square Feet).
I....................	Not hereby limited.	Not hereby limited.
II....................	3 to 7	15,000
	2	120,000
III....................	3 to 4	12,000
	2	60,000
IV....................	3	10,000
	2	60,000
V....................	2	60,000

(e) In buildings on wooden wharves, such units of occupancy shall not exceed twenty thousand square feet in area.

(f) The maximum areas provided in this section for buildings of Division 1, and for buildings of Divisions 2 and 3 less than six stories in height, may be increased fifty per cent if the entire floor area is protected with automatic sprinklers.

[**As amended by Ord. 1943, ch. 3*]

Sect. 802. Separation of Occupancies.— Group F occupancies shall be separated from other occupancies, and fire divisions of Group F occupancy shall be separated from adjoining fire divisions as specified in Part 13. Two tenants shall be separated by partitions of at least one-hour and, in a basement, at least two-hour fire-resistive rating.

Sect. 803. Exterior Walls.— (a) Exterior walls or parts of walls, except where fronting on a street, which are less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions, except doorways and windows in the first story fronting on a public way, shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

***Sect. 804. Enclosure of Vertical Openings.**— (a) Elevator shafts, ventilating shafts and other vertical openings except stairways and ramps, shall be enclosed.

(b) Ramps for the movement of freight shall be enclosed as specified in Part 15 or shall be provided with automatic-closing Class A fire doors which will serve as a fire stop between stories. A ramp with such doors shall not be counted as a required exit.

(c) In buildings of Division 1 and in retail stores, stairways and ramps other than for freight, serving only basements, first and second stories, need not be enclosed. Exit stairways and ramps which pierce only one floor, except as provided in the preceding sentence, shall be enclosed in the story above or below. Other exit stairways and ramps shall be enclosed in all stories in which they occur.

(d) This section shall not be held to require enclosure of mezzanine floors nor of vertical openings in such floors. The provisions of this section shall not apply to book stacks of incombustible material in libraries of Type I or Type II construction.

(e) Ramps which are used for the movement of automobiles from one story to another, or for a similar purpose, shall be enclosed or shall be provided with automatic-closing, Class A fire doors which will serve as a fire stop between stories. A ramp with such doors shall not be counted as a required exit.

(f) Doors which are part of an automobile ramp enclosure may be kept normally open but shall be so equipped as to close automatically in case of fire.

(g) Mechanical stairways or mechanical conveyors and ramps may be installed with manually operated closing devices satisfactory to the commissioner.

[**As amended by Ord. 1943, ch. 3*]

Sect. 805. Exits.— Every portion of a Group F building except library book stacks three levels or less in height shall be provided with exits as specified in Part 18.

*Sect. 806. **Light and Ventilation.**— Rooms used by human beings shall be provided with light and ventilation by means of windows or skylights or with artificial light and a ventilating system.

[**As amended by Ord. 1943, ch. 3*]

†Sect. 807. **Fire-Extinguishing Apparatus.**— (a) Automatic sprinklers shall be installed in cellars and basements of which the floor area is more than fifteen hundred square feet.

(b) Buildings of Divisions 2 and 3, six or more stories in height shall be equipped throughout with automatic sprinklers.

(c) Buildings of Division 4 of Type III, Type IV or Type VI construction or on wooden wharves, more than five thousand square feet in area of units, and buildings of Type I, Type II or Type V construction on incombustible wharves, more than twenty thousand square feet in area, shall be protected by automatic sprinklers.

(d) In buildings more than two stories high either portable fire-extinguishers, not less than one for every twenty-five hundred square feet of floor area and at least one in each story, or first aid standpipes, shall be provided.

(e) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

(f) Garages shall have automatic sprinklers and other suitable fire-fighting apparatus when floor area exceeds ten thousand square feet on any one floor or if the height is five stories or more. Hangars shall have approved fire-extinguishing apparatus.

[*†As amended by Ord. 1943, ch. 3*]

PART 9.

SPECIAL REQUIREMENTS FOR GROUP G OCCUPANCY: COMMERCIAL BUILDINGS OF NON-HAZARDOUS OCCUPANCY.

***Section 901. Group G Occupancy: Type, Height, Area.**— (a) Group G shall include such occupancies as —

Division 1. Ice, power and pumping plants, cold storage rooms and plants, creameries, breweries and other similar buildings.

Division 2. Factories and workshops using incombustible and non-explosive materials.

Division 3. Buildings for the storage or sale of incombustible and non-explosive materials.

(b) Buildings or parts of buildings classified for occupancy in Group G shall be limited as to type of construction, height and area of units, as follows:—

Type of Construction.	Height in Stories.	Maximum Area of Unit in Square Feet Accessible From		
		Minimum within block Less than 30%.	30% and less than 50% of perimeter.	More than 50% of perimeter.
I............	Not hereby limited.			
II...........	8	10,000	15,000	40,000
	2	15,000	15,000	80,000
	1	15,000	15,000	Not hereby limited.
III..........	4	10,000	15,000	20,000
	2	15,000	15,000	40,000
	1	15,000	15,000	Not hereby limited.
IV...........	3	10,000	15,000	20,000
	2	15,000	15,000	30,000
	1	15,000	15,000	Not hereby limited.
V............	2	6,000	8,000	10,000
	1	6,000	8,000	20,000
VI...........	2	3,000	5,000	10,000

NOTE.— Where areas in 1 story buildings are not hereby limited, the maximum distance from any point to an exit from the building shall be 175 lineal feet.

The maximum area of Type IV units may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

[**As amended by Ord. 1943, ch. 3*]

Sect. 902. Separation of Occupancies.— Group G occupancies shall be separated from other occupancies, and fire divisions of Group G occupancy shall be separated from adjoining fire divisions as specified in Part 13.

Sect. 903. Exterior Walls.— (a) Exterior walls or parts of walls, except where fronting on a street, which are less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

***Sect. 904. Enclosure of Vertical Openings.**— (a) Elevator shafts, ventilating shafts, and other vertical openings, except stairways and ramps shall be enclosed.

(b) Ramps for the movement of freight shall be enclosed as specified in Part 15 or shall be provided with automatic-closing Class A fire doors which will serve as a fire stop between stories. A ramp with such doors shall not be counted as a required exit.

(c) Stairways and ramps other than for freight which pierce only one floor shall be enclosed in the story above or below but such stairways or ramps which serve as required exits from one story shall be enclosed in the other story. Other stairways and ramps shall be enclosed in all stories in which they occur.

(d) This section shall not be held to require enclosure of mezzanine floors nor of vertical openings in such floors.

(e) Doors which are part of an automobile ramp enclosure may be kept normally open but shall be so equipped as to close automatically in case of fire.

(f) Mechanical stairways or mechanical conveyors and ramps may be installed with manually operated closing devices satisfactory to the commissioner.

[**As amended by Ord. 1943, ch. 3*]

Sect. 905. Exits.— Every portion of a building shall be provided with exits as specified in Part 18.

†Sect. 906. Light and Ventilation.— Rooms used by human beings shall be provided with light and ventilation by means of windows or skylights or with artificial light and a ventilating system.

[*†As amended by Ord. 1943. ch. 3*]

***Sect. 907. Fire-Extinguishing Apparatus.**— (a) Automatic sprinklers shall be installed in all cellars and basements, of Division 2 and 3, of which the floor area is more than fifteen hundred square feet.

(b) Automatic sprinklers shall be installed throughout buildings of Division 2 or 3, of Type IV construction more than seventy-five hundred square feet in area.

(c) In buildings more than two stories high either portable fire-extinguishers not less than one for every thirty-five hundred square feet of floor area and at least one in each story, or first aid standpipes shall be provided.

(d) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

[**As amended by Ord. 1943, ch. 3*]

PART 10.

SPECIAL REQUIREMENTS FOR GROUP H OCCUPANCY: UNLIMITED HABITATIONS AND LARGE DWELLINGS.*

[**As amended by Ord. 1943, ch. 3*]

†**Section 1001. Group H Occupancy: Type, Height, Area.**—(a) Group H shall include such occupancies as —

Division 1. Hotels, apartment hotels, dormitories, lodging houses, convents, monasteries, and club houses, with sleeping accommodations for ten or more persons, or for more than three families, or for more than two families above the first story, and without kitchens in the individual apartments.

Division 2. Apartment houses accommodating more than three families, or more than two families above the first story, and with kitchens in the individual apartments.

(b) Buildings or parts of buildings classified for occupancy in Group H and of the several types of construction shall not exceed in height and area of units of occupancy the following limits:—

Type of Construction.	Stories.	Maximum Area of Unit (Square Feet.)
I....................	Not hereby limited.	Not hereby limited.
II....................	10	12,000
III....................	3	8,000
IV....................	3	6,000
VI....................	3	2,400

Type V construction shall not be used in buildings of Group H.

(c) Assembly halls in Group H buildings shall be classified in Group A or Group B as the case may be, and shall conform to the requirements of this code for the group in which they are so classified.

(d) The first floor of buildings more than two thousand square feet in area and more than three stories in height shall be of Type I or Type II construction. The basement ceilings of other buildings shall be of at least one-hour fire-resistive construction. All ceilings of buildings more than two thousand square feet in area and three stories or more in height shall be of at least one-hour fire-resistive construction.

(e) Partitions forming separations between adjoining apartments shall be of not less than one-hour fire-resistive construction.

(f) Buildings of Type VI shall not be used for more than four families, nor more than two families above the first story.

[†*As amended by Ord. 1943, ch. 3*]

Sect. 1002. Separation of Occupancies.— Group H occupancies shall be separated from other occupancies, and fire divisions of Group H occupancy shall be separated from adjoining fire divisions as specified in Part 13. A garage of not more than six cars capacity shall be separated from a Group H occupancy as specified in Part 12.

Sect. 1003. Exterior Walls.— (a) Exterior walls or parts of walls, except where fronting on a street, which are less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings in such walls which are less than seven feet six inches from a property line shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than fifteen feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

‡Sect. 1004. Enclosure of Vertical Openings.— (a) Vertical shafts and floor openings, except as hereinafter mentioned, shall be enclosed.

(b) Except as otherwise noted herein, stairways and ramps shall be enclosed in all stories in which they occur as specified in Part 15. Stairways serving as exits from sleeping rooms shall be enclosed in all stories. Stairways serving only basement rooms for the use of the public need not be enclosed. Stairways serving only rooms for use of public in the basement, first and second story need not be enclosed. Auxiliary stairway within an apartment serving only two floors need not be enclosed.

(c) This section and Part 15 shall not be held to require enclosure of mezzanine floors in Group H buildings nor of vertical openings in such floors.

[‡*As amended by Ord. 1943, ch. 3*]

***Sect. 1005. Exits.**— (a) Every portion of a Group H building shall be provided with exits as specified in Part 18.

(b) Every apartment of less than four rooms shall have at least one exit opening upon a corridor which has at least two remote exits, or such

apartment shall have two remote exits. Every apartment of four or more rooms shall have at least two remote exits. Such exits may open into a common corridor which has at least two remote exits.

(c) Every exit from an apartment shall not be more than fifty feet from the nearest exit from the story.

(d) Corridors which serve as common exits from two or more apartments shall have walls of at least one-hour fire-resistive construction. Corridors, including their changes in directions and extensions beyond separations serving as required egress, shall be at least thirty-six inches wide. If more than fifty feet and less than seventy-five feet in length they shall be at least forty-eight inches wide. If seventy-five or more feet in length they shall be at least sixty inches wide.

(e) Doors affording access from a stairway to a roof shall not be so locked as to prevent egress to the roof in emergency.

(f) Every stairway and corridor common to two or more apartments shall be adequately lighted at all times as determined by the building commissioner.

[**As amended by Ord. 1943, ch. 3*]

†**Sect. 1006. Light and Ventilation.**— (a) Kitchens having a floor area more than seventy square feet and dining rooms, within apartments, all sleeping rooms and living rooms shall be provided with light and ventilation by means of windows in the exterior walls. The area of windows in kitchens shall not be less than one eighth of the floor area thereof, nor less than eleven square feet. Windows in toilets or bathrooms shall not be less than one eighth of the floor area thereof nor less than six square feet. Windows shall be arranged to open for ventilation on not less than one half the required area.

(b) Every window required by paragraph (a) of this section shall front upon a street, alley or open passageway not less than fifteen feet wide, or upon a public park, cemetery, railroad right of way or other similar approved open space, or upon a yard or court of the dimensions herein specified. A court upon which such a window fronts shall be open to the sky and no cornice, balcony, stairway, fire escape or other construction shall encroach upon the required open area thereof herein specified. The height of a court shall be measured from the sill of the lowest window required to front upon it. The width and the horizontal area of such court shall not be less than as provided in the following numbered paragraphs (1) to (5), inclusive.

(1) If the court is open at both opposite ends for its full width and full height to a street, alley, park, or other permanently open space, not less than fifteen feet wide, or to a yard, it shall be a through court. The least width of such court shall be not less than six feet nor less than one tenth its length from open end to open end measured along the center line and not necessarily in a straight line. The width of such court at any level more than fifty feet above the sill of the lowest window required to front upon it shall be not less than six feet plus one eighth the excess of such height over fifty feet, except a court the length of which is less than five times its least width. If windows required by this section face a wall on the opposite side of a through court in which windows also required by this section

occur, the width of the court as determined by the foregoing requirements shall be increased by fifty per cent. The width of a through court need not, however, exceed the width required in this section for an inner court of the same height.

(2) If the court is open at one end for its full width and full height to a street, alley, park, or other permanently open space not less than fifteen feet wide, or to a yard, it shall be an outer court. The least width of such court shall be not less than eight feet nor less than one fourth its horizontal length measured along the center line, and not necessarily in a straight line. The width of such court at any level more than fifty feet above the sill of the lowest window required to front upon it shall be not less than eight feet plus one eighth the excess of such height over fifty feet, except a court the length of which is less than twice its least width. If windows required by this section face a wall on the opposite side of an outer court in which windows also required by this section occur, the width of the court as determined by the foregoing requirements in this paragraph shall be increased by fifty per cent. The width of an outer court need not, however, exceed the width required in this section for an inner court of the same height.

(3) Every court which is not open at one or both ends as provided for an outer court or a through court shall be an inner court. The least width of an inner court shall be not less than ten feet. The width of such court at any level more than fifty feet above the sill of the lowest window required to front upon it shall be not less than ten feet plus one eighth the excess of such height over fifty feet. If windows required by this section face a wall on the opposite side of an inner court in which windows also required by this section occur, the width of the court as determined by the foregoing requirements in this paragraph shall be increased by fifty per cent. The horizontal area of an inner court shall be not less than three hundred square feet nor less above any floor level than sixty square feet for each story below said level served by such court. Every inner court shall be provided with an intake for fresh air, consisting of a court, corridor, passageway or ventilating duct, of which the area of cross-section below the level of the top of the lowest required window shall be not less than one fifteenth the maximum required area of the court. Such intake or the required area thereof shall be permanently open and unobstructed except for a grille or screen at least eighty per cent open at one or both ends and shall extend from the court to a street, alley, park, or other permanently open space, not less than fifteen feet wide, or to a yard, above the level of the ground thereof.

(4) Windows required by paragraph (a) of this section may front upon an open recess from the street, alley, park, court, yard or other open space from which they derive light and ventilation, provided the width of the recess is not less than four feet nor less than its horizontal depth, and its depth is not more than six feet. A recess from an inner court of width less than the required width of the court of which it is a part shall be disregarded in computing, for the purpose of this section, the area of the court.

(5) The length of outer courts T-shaped in plan shall be measured from the open end to the end of each branch independently. A branch,

open at only one end, of a through court, shall be considered to be a par of an outer court of length measured from the nearest open end to the closed end of the branch, in determining the width of such branch. Where a recess occurs at the closed end of an outer court the length of the court shall include the depth of the recess. Adjoining courts which conform independently to this section may be combined by omission of dividing walls. An inner court between two sections of a through court may be disregarded in computing the length of the through court. Other arrangements of courts shall be measured for the purposes of this section as determined by the commissioner with a view to providing for every required window light and ventilation substantially as herein specified.

(6) Courts of exceptional form may be approved by the building commissioner if in volume, lighting and ventilating properties they are in his opinion the equivalent of the courts above described.

(c) Every kitchen having a floor area not more than seventy square feet within an apartment and every room containing a water closet, shall be provided with light and ventilation by means of a window, except as specified in paragraph (d) of this section, in an exterior wall or in a ventilating shaft or, if such room is immediately under a roof, by a skylight in the roof. Such window or skylight shall have an area not less than three square feet nor less than one tenth of the floor area of the room, and shall be arranged to open for ventilation not less than three square feet nor less than one twentieth the floor area of the room. Such windows shall front upon an open space or a ventilating shaft of which the width shall be not less than three feet and of which the horizontal area shall be not less than fifteen square feet. If the height of such space or shaft above the sill of the lowest window served is in excess of fifty feet, the width thereof shall be increased one half foot and the area eight square feet for every ten feet or fraction of such excess. If such ventilating shaft is covered, the covering shall be a skylight with openings under the edges thereof on at least three sides equal in the aggregate to at least twice the required area of the ventilating shaft.

(d) Rooms containing water closets need not have windows as specified in paragraph (c) of this section if they are provided with adequate artificial light and an approved system of mechanical ventilation which will completely exhaust the air in the room at least four times per hour. A kitchen having a floor area not more than seventy square feet within an apartment need not have windows if it is so provided with artificial light, and such mechanical ventilation or ventilation by means of a ventilating exhaust duct with at least one square foot net area of cross-section independent of ducts from other rooms to a point above the roof. A kitchen ventilated as provided in this paragraph or by a ventilating shaft shall have a permanent opening of adequate size for fresh air which may, however, be drawn from other rooms in the apartment.

(e) Dining rooms in hotels, dining rooms common to more than one family, kitchens serving such dining rooms and other kitchens and rooms for eating purposes except those within apartments, shall be provided with light and ventilation as specified for kitchens and dining rooms respectively

in paragraphs (a) and (b) of this section or shall have artificial light and an approved system of mechanical ventilation providing not less than four complete changes of air per hour.

(f) The boundary line of a lot on which a building is to be erected subject to the provisions of this section, unless it is a common boundary between such lot and a street, alley, public park, cemetery, railroad right of way or other similar, permanently open space, not less than fifteen feet wide shall be a boundary to an adjacent court or ventilating shaft required by this section as though a wall without windows were erected on such line. If there is, appurtenant to such lot, an easement for light and air over a portion of an adjoining lot, in terms which assure that the easement will remain in force and effect so long as any windows require it for light and ventilation under the provisions of this code, and duly recorded in the registry of deeds for Suffolk county, the portion subject to such easement may be considered to be part of such lot for the purposes of this section. No building or structure shall be erected in such manner as to reduce the light and ventilation in a building on the same lot subject to the provisions of this section below the requirements thereof, nor shall a lot line be moved by sale of land or otherwise so as to permit such reduction by a building on an adjoining lot.

(g) In a residence district, as defined in chapter four hundred and eighty-eight of the acts of nineteen hundred and twenty-four, a building of Division 2 upon a lot which abuts on only one street shall have a yard at the rear. Such yard shall be open and unobstructed above the level of the sills of windows opening thereon required by this section, shall extend the full width of the lot, and shall have a depth, measured from the rear of the building to the rear line of the lot or, if an alley or open passageway lies at the rear of the lot, to the middle line of such alley or passageway, not less than twelve feet nor less than one fourth the height of the building above the sill of the lowest window required to front upon such yard. If the rear line of such lot is other than a straight line the required yard shall have an area not less than twelve feet times the width of the lot at the rear of the building and the building shall be so disposed at the rear as to leave a yard having approved continuity with the yards of adjoining lots. The provisions of this paragraph shall not apply to a lot which abuts at the rear upon a railroad right of way, cemetery, park or other permanently open space, not less than fifteen feet wide. The Boston zoning law (chapter four hundred and eighty-eight of the acts of nineteen hundred and twenty-four) also contains provisions relative to yards.

(h) Every room containing a water closet compartment shall have adequate means for lighting at all times.

[†*As amended by Ord. 1943, ch. 3*]

‡Sect. 1007. Rooms.— (a) In every apartment of an apartment house or apartment hotel, at least one room shall have a floor area not less than one hundred and twenty square feet. However, every kitchen in such apartment shall be not less than six feet wide nor less than forty-eight square feet in area. Every room containing a water closet shall be not less than thirty-three inches wide and shall have a floor area not less than fifteen square

feet. Every other room in such apartment, except closets and vestibules, shall have not less than seventy square feet of floor area.

(b) Rooms in apartments, except closets, shall be at least eight feet high in half their required area, an average of at least six feet high in the remainder of the required area, and not less than four feet high at any point within the required area.

(c) If the walls or floor of a sleeping room or living room are in contact with the ground, the portions thereof in such contact shall be waterproofed as specified in Part 29 or damp proofed in an approved manner, and the interior finish of such portions of the walls of such rooms shall be furred with impervious material. Not more than thirty per cent of the area of the walls enclosing such a room shall be in contact with the ground

(d) The floor of every room containing a water closet shall be of tile, terrazzo, linoleum or other impervious material with a base of similar material around the walls at least four inches high. No water closet shall be enclosed in woodwork placed close about the fixture. The walls of every room containing a water closet shall extend to the ceiling.

[‡*As amended by Ord. 1943, ch. 3*]

***Sect. 1008. Fire Extinguishing Apparatus.**— (a) Automatic sprinklers shall be installed in cellars, basements, workrooms, shops, store rooms and kitchens, in buildings of Type I and Type II construction more than six stories high, and in other buildings more than three stories high.

(b) First aid standpipes, as specified in Part 30, or portable extinguishers, at least one for every twenty-five hundred square feet of floor area and at least one in each story, shall be provided in buildings more than five thousand square feet in area or more than six stories high.

(c) Fire department standpipes and first aid standpipes shall be installed in buildings more than seventy feet high.

[**As amended by Ord. 1943, ch. 3*]

Sect. 1009. Plumbing and Heating.— (a) Every apartment in an apartment house and every apartment of two or more rooms in an apartment hotel shall have within it at least one room containing a water closet and devoted exclusively to use as a bathroom or toilet room. One such room shall be accessible from every sleeping room without passing through another sleeping room. In every such apartment there shall be a lavatory or sink with running water.

(b) Every apartment in a hotel and every apartment in an apartment hotel not included in paragraph (a) of this section shall have within it at least one room containing a water closet, as specified in paragraph (a) of this section, or shall have access in common with other apartments to such a room in the same story or in the next story above or below, by means of a common corridor. Where the number of sleeping rooms without a water closet within the apartment exceeds six in a story, separate toilet rooms for men and for women shall be provided in the same story, plainly marked, and shall contain one water closet for every nine sleeping rooms or fraction of nine. Com-

mon bathrooms shall have means for securely locking the door on the inside. Every such room shall contain at least one lavatory or sink with running water.

(c) In every apartment of an apartment house or apartment hotel which is not adequately heated from a central heating plant, at least one room with a floor area not less than one hundred and twenty square feet shall have a chimney, as specified in Part 21, with a separate flue not less than eight inches in diameter, or a common flue not less than twelve inches in diameter, with a thimble at least six inches in diameter about six feet above the floor.

(d) In buildings more than three stories high, every boiler room or room containing a central heating plant shall be separated from the rest of the building by at least a two-hour separation as specified in Part 13.

PART 11.

SPECIAL REQUIREMENTS FOR GROUP I OCCUPANCY: LIMITED HABITATIONS AND SMALL DWELLINGS.*

[**As amended by Ord. 1943, ch. 3*]

†**Section 1101. Group I Occupancy: Type, Height, Area.**— (a) Group I shall include such occupancies as —

Division 1. Dwellings accommodating not more than three families, nor more than two families above the first story.

Division 2. Dormitories, lodging houses, clubs, convents and monasteries, with sleeping accommodations for less than ten persons.

(b) Buildings or parts of buildings classified for occupancy in Group I shall be limited as to type of construction, height and area of units, as follows: —

Type of Construction.	Stories.	Maximum Area of Unit (Square Feet).
I....................	Not hereby limited.	Not hereby limited.
II..................	5	12,000
III.................	3	8,000
IV..................	3	6,000
VI..................	3	5,000

(c) The basement or cellar ceiling of all Group I buildings, more than three stories in height, shall be of not less than one-hour fire-resistive construction. Boiler rooms in Type IV and Type VI construction with more than one family above the first story shall be separated by walls and ceilings of not less than one-hour separation with any openings in the separation to be Class B fire doors and windows.

[*†As amended by Ord. 1943, ch. 3*]

Sect. 1102. Separation of Occupancies.— Group I occupancies shall be separated from other occupancies, and fire divisions of Group I occupancy shall be separated from adjoining fire divisions as specified in Part 13. A garage of not more than six cars capacity may be constructed as part of a Group I building as specified in Part 12.

Sect. 1103. Exterior Walls.— (a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

[**As amended by Ord. 1943, ch. 3*]

†**Sect. 1104. Enclosure of Vertical Openings.**— (a) Elevator shafts, ventilating shafts and other vertical openings, including stairways, except stairway in a single family occupancy, shall be enclosed.

(b) Where two or more stairways are required as exits at least one shall be enclosed in all stories in which it occurs. Stairways which pierce more than three floors shall be enclosed.

(c) In stairway enclosures not more than three stories high, the doors in stories other than the basement or cellar need not be fire doors if they are of wood not less than one and one half inches thick.

[†*As amended by Ord. 1943. ch. 3*]

‡**Sect. 1105. Exits.**— Group I buildings more than three stories in height, and Group I buildings in which the area of any floor, except the first floor, exceeds fifteen hundred square feet, shall have at least two stairways or ramps, one of which shall be interior and enclosed, and every Group I building where each dwelling does not have its own stairway within its own apartment shall have two stairways, one of which shall be enclosed. A single family house may have one stairway if it is less than three stories in height.

[‡*As amended by Ord. 1943, ch. 3 and Ord. 1954, ch. 7*]

§**Sect. 1106. Light and Ventilation.**— (a) Rooms of Group I buildings used for eating, living or sleeping purposes, shall be provided with light and ventilation by means of windows. The space on which such windows shall open shall not be less than as specified in Part 10 for similar windows in Group H buildings.

(b) Kitchens and rooms containing water closets shall be lighted and ventilated as provided for similar rooms of Group H buildings in Part 10.

[§*As amended by Ord. 1943, ch. 3*]

‖**Sect. 1107. Fire-Extinguishing Apparatus.**— (a) Automatic sprinklers shall be installed in cellars, basements, workrooms, shops, storerooms and kitchens other than in apartments, in buildings more than six stories high.

(b) First aid standpipes, as specified in Part 30, or portable fire-extinguishers, at least one for every twenty-five hundred square feet of floor area, and at least one in each story shall be provided in Group I buildings more than five thousand square feet in area or more than six stories high.

(c) Fire department standpipes and first aid standpipes shall be installed in buildings more than seventy feet high.

(d) This section shall not apply to buildings of Division 1, referred to in section eleven hundred and one.

[‖*As amended by Ord. 1943, ch. 3*]

PART 12.

SPECIAL REQUIREMENTS FOR GROUP J OCCUPANCY: MISCELLANEOUS STRUCTURES.

***Section 1201. Group J Occupancies: Type, Height, Area.**—(a) Group J shall include such occupancies as —

Division 1. Garages for six cars or less.

Division 2. Tanks, towers, advertising signs and similar structures.

Division 3. Amusement park structures, reviewing stands, grand stands and similar structures.

(b) Garages for six cars or less, not exceeding two stories in height nor thirteen hundred square feet in floor area, may be of any type of construction except Type VI. Garages, for three cars or less, one story in height and not exceeding six hundred and fifty square feet in area, may be of Type VI construction.

(c) Structures of Division 2, erected on the roof or on the façade of a building in the first or second fire zone, shall be constructed with incombustible materials, except water tanks, flag poles, isolated signs flat against an exterior wall not more than twenty square feet in area, and isolated signs projecting from an exterior wall; provided, that such projecting signs have a frame of incombustible material, that the combustible material in such projecting signs is no more combustible than wood, that no part of such combustible material is nearer an exterior wall than fifteen inches, and that the surface area of such combustible material is not more than thirty-five square feet on any face and not more than seventy square feet in the aggregate, except that the surface area of such combustible material, if the nearest point thereof is eighteen or more inches from all exterior walls, may be more than thirty-five square feet on a face and more than seventy square feet in the aggregate if the building commissioner certifies on the application for the permit to erect such sign that in his opinion the spread of fire therefrom is no more likely than from a projecting sign having an incombustible frame and two wooden faces each thirty-five square feet in area the nearest point of which wood is fifteen inches from the nearest exterior wall.

(d) Reviewing stands and grand stands may be constructed of masonry, reinforced concrete, steel or wood or any combination thereof. When constructed, except for the seats, of incombustible materials, the size shall not

hereby be limited. When the structure below the deck is constructed of incombustible material, and the decking is of wood or other combustible material, the horizontal distance from front to back shall not exceed one hundred feet. When the entire structure is constructed of wood or other combustible material, the horizontal distance from front to back shall not exceed fifty feet.

(e) Amusement park structures of the open or skeleton framed type may be constructed of any type of construction and are not hereby limited in height and area.

(f) Amusement park structures of the enclosed type, shall be limited as to type of construction, height and area of units, as follows:—

Type of Construction.	Height.		Area of Unit. (Square Feet.)
	Feet.	Stories	
I	Not hereby limited.		Not hereby limited
II	75	4	15,000
III	55	3	10,000
IV	35	2	10,000
V	35	2	5,000
VI	35	2	5,000

(g) Amusement park structures of enclosed type used as places of assembly shall be classified in Group A or Group B in accordance with the definitions thereof.

(h) The maximum areas provided in this section may be increased fifty per cent if the entire floor area is protected by automatic sprinklers.

[**As amended by Ord. 1943, ch. 3 and Ord. 1950, ch. 6*]

Sect. 1202. Separation of Occupancies.— (a) When a garage of size and arrangement to accommodate not more than two cars is constructed as part of a Group H or Group I building, the walls and ceilings of the garage shall be of not less than one-hour fire-resistive construction. When a garage to accommodate more than two but not more than six cars is constructed as part of a Group H or Group I building, the walls and ceiling of the garage shall be of not less than three-hour fire-resistive construction. Openings in such walls shall be protected by Class B fire doors or by fire windows. A garage to accommodate not more than six cars shall be separated from other occupancies and from adjoining fire divisions as specified in Part 13.

(b) In a separation between a garage of Group J occupancy and another occupancy there shall not be more than one opening, and the sill thereof shall be raised one foot above the garage floor. There shall be no opening from a garage directly into a living room, sleeping room or kitchen.

Sect. 1203. Exterior Walls.— Exterior walls or parts of walls, of Group J structures, except where fronting on a street, which are less than five feet from a property line or less than ten feet from another building on the same lot, shall be of not less than one-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows, and such walls which are less than three feet from a property line or less than six feet from another building on the same lot, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows, except that in garages for three cars or less of Type V construction, such walls may be of unprotected metal.

Sect. 1204. Exits.— (a) Reviewing stands, grand stands and similar structures shall be provided with exits not less than four feet wide nor less than one foot in width for each three hundred persons or fraction thereof served. Exits shall have not less than seven feet in clear height nor be more than sixty feet apart.

(b) Where the space under a grand stand, reviewing stand or similar structure is used for any purpose other than ingress and egress, the required exits through this space shall be enclosed by walls, floors, and ceilings of not less than one-hour fire-resistive construction.

(c) Amusement park structures, other than grand stands or similar structures, of either open or enclosed type shall be provided with exits as required for Group B occupancy in Part 4.

Sect. 1205. Aisles and Seating.— Reviewing stands, grand stands and similar structures having more than twenty rows of seats shall have transverse aisles not over sixty feet apart leading to exits. Transverse aisles shall have a clear width not less than thirty inches nor less than one foot for every three hundred persons or fraction thereof served. Where separate seats are not provided or marked off, a width of eighteen inches shall be considered one seat in computing the required width of aisles and exits.

***Sect. 1206. Light and Ventilation.**— Amusement park structures shall be provided with light and ventilation sufficient to avoid dangerous or unhealthful conditions as may be required by the commissioner. They shall be lighted by artificial light sufficiently for safe egress.

[**As amended by Ord. 1943, ch. 3*]

Sect. 1207. Fire-Extinguishing Apparatus.— Fire-extinguishing apparatus shall be provided in buildings and structures of Group J where the fire hazard, in the judgment of the commissioner, is commensurate with that for which such apparatus is specified in buildings of other groups.

Sect. 1208. Floor Finish.— Garages shall have non-absorbent incombustible floor finish.

PART 13.

SEPARATION OF OCCUPANCIES.

***Section 1301. Multiple Occupancies.**— (a) A fire division, whether occupying the whole or a part of a building, shall be limited as to type of construction, height and area as provided in Parts 3 to 12, inclusive, according to its principal occupancy.

(b) Adjoining fire divisions in a building shall be separated by a separation at least as fire-resistive as required by Table A, section thirteen hundred and two.

(c) A fire division may contain two or more units of different occupancies, and every such unit shall be limited as to height above the ground and as to area as provided in Parts 3 to 12, inclusive, according to its occupancy and the type of construction of the building.

(d) Adjoining units of different occupancy in a fire division shall be separated by a separation at least as fire-resistive as specified in Table A, section thirteen hundred and two. Space within a unit of occupancy used for a purpose or process customarily incidental to that occupancy and under the same management and control shall not be considered a separate unit of occupancy unless the floor area of such space exceeds one tenth the area of the fire division in which it is located; but garage use shall not so be considered incidental.

(e) Every unit of occupancy shall conform to the provisions of Parts 3 to 12 of this code for the group and division in which it is classified.

(f) Two adjoining fire divisions may be of different types of construction subject to the following limitations:

(1) Construction required to be of Type I shall not be supported wholly or in part by construction of any other type.

(2) Construction required to be of Type II shall not be supported by construction other than of Type I or Type II.

(3) Construction required to be of Type III shall not be supported by construction other than of Type I, Type II or Type III.

(4) Construction required to be of Type IV shall not be supported by construction other than of Type I, Type II, Type III or Type IV.

(5) Construction required to be of Type V shall not be supported by construction other than of Type I, Type II or Type V.

(6) Construction required to be of Type VI shall not be supported by construction other than of Type I, Type II, Type III, Type IV or Type VI.

(g) Separations, as specified in this code, may be vertical, horizontal, or inclined, depending upon the relative position of the portions of the building to be separated, and shall consist of a system of walls, partitions, floors or other construction of such materials and construction and so arranged as to provide a complete, secure and continuous fire-break of the required fire-resistive rating between the portions of the building separated.

(h) A building more than three stories high used on first floor or basement, for commercial use and adapted for more than two families above the first floor shall be equipped with automatic sprinklers throughout that portion used for commercial use when, in the judgment of the commissioner, public safety demands such protection.

[**As amended by Ord. 1943, ch. 4*]

†**Sect. 1302. Separations.**— (a) Separations between units of occupancy within a fire division and between fire divisions of a building shall be classified, each classification being designated in Table A of this section by the letter or figure symbol set against it, having the following significance:

A — means absolute separation.
4 — means four-hour separation.
3 — means three-hour separation.
2 — means two-hour separation.
1 — means one-hour separation.
N — means no separation required.

(b) An absolute separation shall provide in all its parts effective fire-resistance of not less than four-hour rating as specified in Part 22 and shall have no openings.

(c) A four-hour separation shall provide effective fire-resistance of not less than four-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on each side thereof by automatic-closing Class A fire doors as specified in Part 22. The sum of the areas of such openings in one story shall not exceed one third the area of the separating wall and no single opening shall have a greater area than one hundred square feet.

(d) A three-hour separation shall provide effective fire-resistance of not less than three-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on each side thereof by automatic-closing Class B fire doors as specified in Part 22. The sum of the areas of such openings in one story shall not exceed one third the area of the separsaing wall and no single opening shall have a greater area than two hundred square feet.

(e) A two-hour separation shall provide effective fire-resistance of not less than two-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on one side thereof by automatic-closing Class A fire doors as specified in Part 22. The sum of the areas of such

openings in one story shall not exceed one third the area of the separating wall and no single opening shall have a greater area than two hundred square feet.

(f) A one-hour separation shall provide effective fire-resistance of not less than one-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on one side thereof by automatic-closing Class B fire doors as specified in Part 22.

(g) Walls which form separations between fire divisions shall be fire walls as specified in Part 14. Such walls, whether bearing or non-bearing, shall be solid masonry not less than eight inches thick or reinforced concrete not less than six inches thick. Openings in fire walls shall have fire doors on both sides.

(h) The commissioner may waive in part the requirements of this section for the protection of openings less than two square feet in area subject to such conditions as he shall in each case specify.

(i) A fixed fire window, as specified in Part 22, may be considered equivalent to one Class B fire door in the walls of separations, but two such windows shall not be substituted as equivalent to two doors in an opening where two fire doors are required.

(j) **Table A.**

(1) For required separations between different unit occupancies in on fire division read above the zigzag line. **Exception:** For separation re quirements between units of occupancy of Group J, Division 1 Occupancy, and units in the same fire division of Group H or Group I Occupancy see Section 1202, Part 12.

(2) For required separations between fire divisions read below the zigzag line.

Separations between adjoining fire divisions of Type I, Type II, and Type V construction shall be as listed. If either of two contiguous fire divisions is of Type III, Type IV, or Type VI construction the provisions of the Table shall be modified in accordance with the following:

> The symbol of four hour separation shall be construed to require absolute separation, and the other separation symbols shall be construed to require one hour more than that indicated in the Table.

In the following table ordinates and coordinates are designated by the letters and numbers used in this Code indicating various occupancies. The requirements for separation between fire divisions and unit occupancies are indicated by the number or letter which appears at the intersection of the ordinate and coordinate representing any two contiguous fire divisions or unit occupancies. See paragraph (a) for significance of said numbers and letters.

Table A, (1) — Required Separations Between Different Occupancies in One Fire Division.
(Above Zigzag Line.)

Group.	A	B	C	D1	D2	E1	E2	F1	F2	F3	F4	F5	G1	G2	G3	H1	H2	I1	I2	J1
A	N	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
B	4	3	1	3	2	4	4	2	2	3	3	4	3	2	2	1	1	1	1	2
C	4	2	2	3	2	4	4	1	2	2	2	4	3	2	2	1	1	N	N	2
D1	4	4	4	2	3	4	4	3	3	3	3	4	3	3	3	3	3	3	3	3
D2	4	4	4	4	2	4	4	1	2	2	3	4	3	2	2	1	1	1	1	3
E1	A	A	4	4	A	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
E2	A	A	4	4	A	3	3	2	2	2	2	3	3	2	2	3	3	3	3	3
F1	4	3	3	4	3	3	3	3	N	N	N	3	3	N	N	N	N	N	N	1
F2	4	3	3	4	4	3	3	3	3	N	N	3	3	N	N	1	1	1	1	1
F3	4	4	3	4	4	3	3	3	3	3	N	3	3	1	1	1	1	1	1	1
F4	4	4	3	4	A	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1
F5	4	4	4	4	A	3	3	3	3	3	3	3	3	3	3	4	4	4	4	N
G1	4	4	4	4	A	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
G2	4	4	3	4	3	3	3	3	3	3	3	3	3	2	N	1	1	1	1	1
G3	4	4	3	4	3	3	3	3	3	3	3	3	3	2	2	1	1	1	1	1
H1	4	3	3	4	3	4	4	3	3	3	3	4	3	3	3	3	N	N	N	–
H2	4	3	3	4	3	4	4	3	3	3	3	4	3	3	3	3	3	N	N	–
I1	4	3	3	4	3	4	4	3	3	3	3	4	3	3	3	3	3	2	N	–
I2	4	3	3	4	3	4	4	3	3	3	3	4	3	3	3	3	3	2	2	–
J1	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2

Table A, (2) — Required Separations Between Fire Divisions.
(Below Zigzag Line.)

[†*As amended by Ord. 1943, ch. 4*]

PART 14.

WALLS AND PARTITIONS.

***Section 1401. Definition of Walls for Use or Function.**— (a) Walls and partitions shall be classified for use or function as follows:—

(1) A bearing wall is a wall which supports a floor, roof or other load in addition to its own weight.

(2) A non-bearing wall is a wall which supports no load other than its own weight.

(3) An exterior wall is a wall separating the interior from the exterior of a building, marking the boundary or extent thereof which may be and usually is exposed to the weather on one side.

(4) An interior wall is a wall wholly within a building and protected from the weather.

(5) A party wall is a wall used or adapted for use in common as a part of two buildings. A party wall may be either bearing or non-bearing

(6) A fire wall is an interior wall, bearing or non-bearing, forming part of a separation between two fire divisions of a building, as provided in Part 13.

(7) A partition is an interior wall, bearing or non-bearing, not over one story in height, the chief function of which is to separate two rooms of a story. A partition in one story may be supported by a bearing partition in the story below.

(8) A foundation wall is a foundation in the form of a wall, either exterior or interior; that portion of the exterior bearing wall of a building which is below the grade of adjoining ground.

(9) A retaining wall is a wall of which the chief function is to resist the lateral displacement of liquid, granular or other materials. It may be either bearing or non-bearing, exterior or interior.

(10) A curtain wall is an exterior, non-bearing wall more than one story high and not supported at each floor level, which is laterally stayed either by masonry piers or by the structural frame of the building.

(11) A panel wall is an exterior, non-bearing wall not over one story high, or supported at each floor level.

(12) An enclosure wall is an interior wall, bearing or non-bearing, which encloses a stairway, elevator shaft or other vertical opening.

[**As amended by Ord. 1943, ch. 4*]

†**Sect. 1402. General Requirements for Walls.**— (a) Walls shall have the resistance to fire and to the spread of fire required of them in Parts 3 to 13, inclusive, and Part 15 of this code, but may be finished, except on the outside of exterior walls and within enclosures of vertical openings, with wooden or other combustible wainscoating, insulating or acoustical material. In Type III buildings, there shall be no concealed air spaces between such finish and the wall. In Type V buildings such material shall be protected from fire on both sides by sheet metal or its equivalent. In Type IV or Type VI buildings every hollow space in walls shall be firestopped at floor and ceiling.

(b) Bearing walls shall be so supported and constructed as to be stable and to support their weight and the loads which may be placed upon them without exceeding the stresses allowed for the materials of which they are constructed as provided in Parts 23 to 29, inclusive. Exterior walls, party walls, bearing walls and fire walls and their vertical or lateral supports shall be capable of resisting the pressure of the wind applied to either side.

(c) Court walls shall be of such fire-resistive construction and shall have such limitations as to openings and the protection of openings as are specified for exterior walls in Parts 3 to 12, inclusive.

(d) Exterior bearing walls of buildings of Type I, Type II, Type III and Type IV shall be of four-hour fire-resistive construction as provided in sections one hundred and twenty-six to one hundred and twenty-nine, inclusive, of Part I. Where such exterior walls are required, in Parts 3 to 12, inclusive, to be without openings the panels or non-bearing portions of the walls shall afford resistance of four-hour rating to the spread of fire. Where openings in such exterior walls are required, in Parts 3 to 12, inclusive, to be protected with fire doors or fire windows, the panels or non-bearing portions of the walls shall afford resistance of two-hour rating to the spread of fire. Where the openings in such exterior walls are unrestricted, panels or non-bearing portions of such walls shall be of incombustible construction, excepting, that sash, window frames, blinds, shutters, screens, doors, door frames, door and window trims, their architraves, pilasters and entablatures may be of wood or other not easily inflammable material; and in buildings outside the fire limits isolated pilasters and building cornices may be of wood or some other not easily inflammable material. Furthermore, architectural surfaces, trimmings, plaques, panels or the like of wood covered with metal or other incombustible

material may be applied to the exterior of buildings, and there may be incorporated in the masonry backing the necessary wooden grounds for their attachment, or wooden grounds may be applied to masonry wall if embedded in mortar. Metal cornices and the like may be applied to wooden outriggers and suitable grounds.

(e) In buildings with combustible floors, doorways required to have fire doors shall have incombustible thresholds the full thickness of the wall and doors in their closed positions, and the space thereunder shall be filled solid with masonry. Thresholds may be flush with the floor.

[†*As amended by Ord. 1943, ch. 4*]

Sect. 1403. Lateral Support of Walls.— (a) Walls of any type or construction may be considered to have lateral support where anchored or secured:—

(1) To intersecting walls of equal or better fire-resistance.
(2) To buttresses or piers.
(3) To the floors, roof and framing.

Sect. 1404. Classification of Walls for Type of Construction.— (a) Walls, including partitions, shall be classified for type of construction as follows:—

(1) Reinforced concrete.
(2) Masonry.
(3) Steel frame.
(4) Wooden frame.

(b) Any wall which does not fall readily into one of the classifications of this section shall be assigned thereto by the commissioner according to its pertinent characteristics.

Sect. 1405. Reinforced Concrete Walls.— (a) Reinforced concrete walls may be used for any use or function described in section fourteen hundred and one.

(b) Reinforced concrete walls other than foundation walls shall be supported upon foundations of concrete or masonry or upon construction of masonry, reinforced concrete or structural steel the metal of which, except as otherwise provided in section fourteen hundred and eleven, shall have protection against fire of at least the rating required for the wall itself, and not less than two-hour fire-resistive protection. Reinforced concrete walls shall not be supported upon wood except wooden piles or other approved underwater construction of wood.

(c) The pertinent provisions of Part 26 shall apply to walls of reinforced concrete.

(d) Reinforced concrete bearing walls shall have a thickness of at least one twenty-fifth the height or length between supports, whichever is the lesser dimension.

(e) Foundation walls of reinforced concrete shall be not less than eight inches thick.

(f) Non-bearing walls of reinforced concrete shall have a thickness of at least one sixtieth of the height or length between lateral supports, whichever is the lesser dimension, and shall not be thinner than three inches. Reinforced concrete beams which serve in part as walls shall conform to the requirements for non-bearing walls.

(g) Party and fire walls of reinforced concrete shall be at least six inches thick.

(h) Walls of reinforced concrete may be covered with a veneer of masonry or other material adequately supported but such veneer shall not be considered to be a part of the wall for the purposes of this section.

(i) No chase or recess shall be cut or formed in a reinforced concrete wall so as to impair its stability, or to reduce the minimum thickness to less than four inches.

(j) Where structural steel beams or other metal members frame into exterior, party, fire or enclosure walls of reinforced concrete, the ends shall have protection against fire of the rating specified for the wall. Where wooden joists, beams or other combustible members frame into such walls, the ends shall be separated from the opposite side of the wall and from such members framing into the opposite side of the wall by not less than four inches of concrete. In buildings of Type III, Type IV or Type VI construction party walls and fire walls shall extend through the roof as provided in section fourteen hundred and thirteen.

(k) Exterior and bearing walls of reinforced concrete shall be anchored to the floor and roof construction as specified in Parts 16 and 17.

***Sect. 1406. Masonry Walls.**— (a) Masonry may be used for walls of any use or function described in section fourteen hundred and one. Specifications for masonry in this chapter shall also apply to plain concrete.

(b) Masonry walls and piers, other than foundation walls, shall be supported upon foundations of concrete or masonry, or upon construction of masonry, reinforced concrete or structural steel the metal of which, except as otherwise provided in section fourteen hundred and eleven, shall have protection against fire of at least the rating required for the wall itself, and not less than two-hour fire-resistive protection. Masonry walls and piers shall not be supported upon wood except wooden piles or other approved underwater construction of wood, but this provision shall not apply to fire stopping and nogging.

(c) Exterior bearing walls of masonry shall have a thickness of at least one sixteenth the height or length between lateral supports in the top story of a building and at least one twentieth such height or length in stories other than the top, whichever is the lesser dimension. Masonry exterior bearing walls supporting the walls of Type V or Type VI buildings shall be not less than eight inches thick.

(d) Exterior bearing walls of masonry shall have at least the thickness given in the following tables:

Table A: Exterior Bearing Walls of Masonry for Group A, B, C, E, F, G, J Occupancy.

NOTE.— Hollow masonry units may be used in walls of the thickness given only on the top four stories. Minimum thickness of walls is given in inches.

Story.	Height of Wall in Stories.							
	8.	7.	6.	5.	4.	3.	2.	1.
Eighth	12	—	—	—	—	—	—	—
Seventh	12	12	—	—	—	—	—	—
Sixth	12	12	12	—	—	—	—	—
Fifth	16	12	12	12	—	—	—	—
Fourth	16	16	12	12	12	—	—	—
Third	16	16	16	12	12	12	—	—
Second	20	16	16	16	12	12	12	—
First	20	20	16	16	16	12	12	12
Basement	20	20	20	16	16	16	12	12

Table B: Exterior Bearing Walls of Masonry for Group D, H, I Occupancy.

NOTE.— For special provisions with respect to single-family, Group I occupancy, see the following Table C.

Story.	Height of Wall in Stories.							
	8.	7.	6.	5.	4.	3.	2.	1.
Eighth	12	—	—	—	—	—	—	—
Seventh	12	12	—	—	—	—	—	—
Sixth	12	12	12	—	—	—	—	—
Fifth	12	12	12	12	—	—	—	—
Fourth	12	12	12	12	12	—	—	—
Third	16	12	12	12	12	12	—	—
Second	16	16	12	12	12	12	8	—
First	16	16	16	12	12	12	12	8
Basement	16	16	16	16	12	12	12	12

Table C: Exterior Bearing Walls of Masonry for Group 1 Occupancy, Single-Family Dwellings Not Over Three Stories High, Supporting Floors Not Over Twenty Feet in Span.

Story.	Height of Wall in Stories.		
	3.	2.	1.
Third	8	-	-
Second	8	8	-
First	12	8	8
Basement	12	12	8

(e) Interior bearing partitions of masonry, supporting not more than one floor and a roof shall have a thickness of at least one twentieth the height or length between lateral supports, whichever is the lesser dimension, and at least six inches. Such partitions, not over one story high, supporting stairs, stair landings, platforms, a mezzanine floor, or the like, shall have a thickness of at least one twentieth the height or length between lateral supports, whichever is the lesser dimension, and at least three and one half inches. Other interior bearing walls of masonry shall have at least the thickness required in this section for masonry exterior bearing walls.

(f) Bearing party walls of masonry shall be solid not less than twelve inches thick. Non-bearing party walls and bearing or non-bearing fire walls, of masonry shall be solid not less than eight inches thick.

(g) Exterior masonry panel walls shall be not less than three and one half inches thick. Panel walls more than four feet high, and curtain walls, of masonry shall be not less than eight inches thick. Panel or curtain walls of metal or fire-resisting, impervious material may be backed up with masonry at least two inches in thickness.

(h) Non-bearing masonry partitions and enclosure walls shall have a thickness of at least one forty-fifth the height or length between lateral supports, whichever is the lesser, and at least three inches.

(i) The minimum thickness specified in this section for masonry walls, except as otherwise provided in this paragraph, shall be exclusive of unbonded veneer, plaster or other covering on either face of the wall. The minimum thickness specified in this section for non-bearing partitions and enclosure walls shall be inclusive of plaster which is at least one half inch thick on either or both sides, and when the masonry beneath the plaster is at least three inches thick.

[**As amended by Ord. 1943, ch. 4*]

†**Sect. 1407. Bond in Masonry.**— (a) Brick walls shall be bonded with at least one full header, every other brick in every sixth course, on both faces and the interior of the walls.

(b) In homogeneous masonry walls of stone, bond stones shall be uniformly distributed and shall have a cross-section not less than ten per cent of the area of the wall.

(c) In homogeneous masonry walls of structural clay tile or of solid or hollow concrete or gypsum blocks or of similar masonry units, unless all the units are the full thickness of the wall, the two faces of the wall shall be bonded together through the wall, by varying the thickness of units in alternate courses so that the blocks will overlap across the wall not less than three and one half inches.

(d) Walls of structural clay tile, concrete blocks or similar masonry units, faced with brick, in which the backing is bonded as required for the material of which it is built and the brick facing is bonded to the backing as required in a brick wall, shall be considered to have the strength and stability of a homogeneous wall of the same total thickness of the weaker material.

(e) A wall of stone, brick, structural clay tile, concrete blocks or other masonry units faced with stone ashlar bonded to the wall as herein provided, shall be considered to have the strength and stability of a homogeneous wall of the same total thickness of the weaker material. In order so to be considered a part of the wall, the ashlar facing shall be laid in a full bed of mortar, shall be not less than three and one half inches thick and bond stones shall be uniformly distributed in all or at least in alternate courses, not less than seven and one half inches thick, nor less than four inches thicker than the remainder of the facing, and constituting not less than twenty per cent of the area of the wall.

(f) Brick, stone or block facing may be considered to be bonded to backing of plain or reinforced concrete when the facing, with all the provisions for bond required for a facing backed with masonry, is laid in advance of the pouring of concrete, and the concrete is poured in direct contact with the facing, embedding the header brick or bonding units.

(g) Masonry walls covered with a veneer not bonded to the wall as provided for a facing in this section shall be considered to have a thickness equal to that of the wall exclusive of the veneer.

(h) Hollow walls of brick, laid with every alternate brick in every other course on each side of the wall a full header, or any equivalent bond, may be used where walls of structural clay tile may be used.

[†*As amended by Ord. 1943, ch. 4*]

‡**Sect. 1408. Lateral Support of Masonry.**— (a) Masonry bearing walls, exterior walls, and other masonry walls, which depend upon intersecting walls for lateral support shall be bonded to such walls at intersections and corners by having each unit if other than brick alternately overlap by at least one half the thickness of the wall at the intersection, and if of brick have each alternate brick overlap by half the length of the brick, or a group of not over six bricks overlap in alternating groups at least half the thickness of the wall.

(b) Masonry walls which depend upon anchorage to the frame of a building for lateral support shall be tied to the frame by suitable anchorage approved by the commissioner.

(c) Exterior and bearing walls of masonry shall be anchored to the floor and roof construction as specified in Part 16.

[‡*As amended by Ord. 1943, ch. 4*]

Sect. 1409. Masonry Piers.—(a) In walls with openings such that the portion of wall between openings constitutes a pier, such portion of wall shall be computed and constructed as required for piers. The height of such a pier, with a continuous wall above and below the openings shall be taken as the height of the openings.

(b) When the clear horizontal distance between piers in masonry walls exceeds ten feet they shall be considered isolated piers.

(c) Isolated piers shall be built of solid units, for which hollow units filled with concrete shall not be substituted. The unsupported height of isolated piers shall not exceed twelve times their least dimension.

Sect. 1410. Beam Supports on Masonry Walls.— (a) Joists, beams and other structural members shall not bear directly on hollow walls or walls of hollow units, but shall be supported on a sufficient number of courses of solid units or equivalent concrete or a metal plate or grillage sufficient to distribute the load to the webs and shells in such manner as not to exceed the allowable unit stress.

(b) Where structural steel beams or other metal members frame into exterior, party, fire or enclosure walls of masonry, the ends shall have protection against fire of the rating specified for the wall. Where wooden joists, beams or other combustible members frame into such walls the ends shall be separated from the other side of the wall and from members framing into the other side of the wall by not less than four inches of masonry.

***Sect. 1411. Masonry Chases, Recesses, Corbels and Lintels.**—

(a) There shall be no chases in masonry bearing or exterior walls eight inches or less in thickness or within the required area of a pier, and no chase in a bearing, exterior or fire wall or pier shall reduce the thickness thereof to less than eight inches. No horizontal or diagonal chase shall be allowed except subject to the limitations and conditions provided in this section for recesses.

(b) Recesses for stairways, elevators or other purposes may be made in masonry bearing, or exterior walls, but in no case shall the walls at such points be reduced to less than the thickness required in the fourth story. Such walls of reduced thickness shall have such additional lateral support as may be necessary. Recesses in masonry bearing or exterior walls for radiators and similar purposes, shall have not less than eight inches of masonry at the back. Such recesses shall be not more than eight feet in length unless the wall at the back may be considered a curtain or panel wall, and they shall then be arched over or spanned with lintels.

(c) No chases or recesses shall be permitted in fire or party walls that will reduce the thickness below the minimum specified in this code.

(d) Chases and recesses may be built as provided in this section, but shall not be cut in masonry walls of hollow masonry units or in hollow walls of brick.

(e) Chases shall be fire-stopped at floor and ceiling levels.

(f) Corbels may be built in masonry walls to furnish bearing for floors or roof but such corbels shall not project from the face of the wall more than one fourth the thickness of the wall nor more than one fourth the height of the corbel. Corbels shall be built with solid masonry units and thoroughly bonded to the wall. No corbel in a masonry wall less than twelve inches thick shall be used for the support of a floor or roof.

(g) Chimneys constructed of the same material as that of the wall, and lined as provided in Part 21, may be supported by corbels of which the projection is not more than one fourth the height nor more than the thickness of the wall, but no chimney shall be supported on a corbel from a wall less than twelve inches thick.

(h) Openings in masonry walls for doorways and windows shall have well buttressed arches or lintels of incombustible material. Structural or reinforcing steel in such lintels shall have protection against fire of the rating required for the wall, but not less than two-hour fire-resistive protection; except that the masonry over an opening may be supported by a steel plate, angle or similar member not fireproofed on the under side, if the width of the opening does not exceed six feet in bearing walls and ten feet in non-bearing walls, or if the member so unprotected is itself supported, at intervals not exceeding six feet in bearing walls and ten feet in non-bearing walls, from a beam or other adequate structure which has the required protection.

[**As amended by Ord. 1943, ch. 4*]

†**Sect. 1412. Masonry Foundation Walls.**— (a) Masonry foundation walls shall conform to the requirements for foundations of Part 29.

(b) Sand lime brick, gypsum tile and cinder concrete poured in place shall not be used in foundation walls nor as part of the required thickness thereof. Wood shall not be used in the foundations of permanent structures except as provided in Part 29.

(c) Rough or random rubble stone masonry without level beds shall not be used for foundation walls more than ten feet high or supporting buildings more than forty-five feet high.

(d) Masonry foundation walls shall be at least as thick as the wall supported, and not less than the following thickness:—

Minimum Thickness (Inches) of Masonry Foundation Walls.

Concrete	8
Solid masonry (except rubble)	8
Hollow masonry	12
Rubble masonry	20

(e) Foundation walls and retaining walls, which depend upon a floor or superimposed structure for resistance to overturning shall not be back-filled until so supported or properly shored to the satisfaction of the commissioner. Walls damaged by premature back-filling shall be removed and replaced if so required by the commissioner.

(f) Masonry foundation walls supporting wood shall be carried at least eight inches above adjoining ground and shall be effectually sealed to prevent moisture from reaching the wood through capillary action.

(g) Masonry in foundation walls shall be laid in cement mortar or cement-lime mortar.

[†*As amended by Ord. 1943, ch. 4*]

Sect. 1413. Parapet Walls.— (a) In buildings of Type III, Type IV or Type VI construction not more than forty-five feet in height, party walls and fire walls shall extend through the roof not less than twelve inches, and in such buildings more than forty-five feet in height, not less than thirty inches. Masonry walls extending above the roof shall have a coping of incombustible material.

(b) In such buildings, exterior walls required by Parts 3 to 12, inclusive, to be of four-hour fire-resistive construction without openings, shall extend above the roof, as provided in this section for party walls.

‡**Sect. 1414. Use of Existing Masonry Walls.**— An existing masonry wall may be used in the construction of a post-code building and in the repair, alteration or enlargement of a building providing it meets the requirements of this code, and is structurally sound or can be made so by reasonable repairs. Existing masonry walls which are structurally sound but which are of insufficient thickness for their proposed use shall be strengthened by an addition of similar material not less than eight inches in thickness laid in mortar of required proportions. Foundations and lateral supports shall be provided as required for newly constructed walls under similar conditions. Such additions or linings shall be thoroughly bonded to the existing masonry by toothings bonded with the new masonry and built solidly into openings cut in the old masonry at least four inches deep. Such toothings shall be distributed uniformly throughout the wall and shall aggregate in vertical cross-sectional area not less than fifteen per cent of the total vertical area of the wall or lining. If the existing wall is covered with plaster or other covering that might impair the bond of the lining, such covering shall be stripped off and the masonry cleaned. The repair, lining, or other strengthening of an existing masonry wall to be used in the construction of a post-code building and in the repair, alteration or enlargement of a building shall be in every respect satisfactory to the commissioner and subject to such conditions as he may in any case prescribe.

[‡*As amended by Ord. 1943, ch. 4*]

Sect. 1415. Masonry Veneer.— (a) Unbonded masonry veneer may be used as a covering for a wall of any type of construction with or without air space. It shall not be regarded as a structural part of the wall or as contributing to its strength or stability, but it may serve as protection from the weather and where built without hollows or air spaces it may serve as protection for metal against fire. Gypsum shall not be used in veneer exposed to the weather.

(b) Masonry veneer shall be anchored to the backing, if of masonry, by headers or bond units, built at least three and one half inches into the back-

ing, uniformly distributed, and having an area at least one fortieth the area of the wall, or by approved non-corrodible metal ties spaced not further apart than one foot, or three times the thickness of the veneer except that masonry veneer of thin flat stones on edge shall be anchored every twelve inches in all horizontal joints by non-corrodible anchors not less than one quarter inch in least dimension dowelled at least one inch into the top of veneer stones and well secured to the backing.

Sect. 1416. Steel Frame Walls.— (a) Walls framed with structural steel may be used for any of the functions described in section fourteen hundred and one.

(b) The frames of exterior steel frame bearing walls shall have fire protection of the rating specified for the exterior bearing walls of the building according to its type of construction in sections one hundred and twenty-six to one hundred and thirty, inclusive, of Part 1 and in Parts 3 to 12, inclusive.

(c) The frames of interior steel frame bearing walls shall have fire protection as required for structural steel columns in Parts 16 and 17.

(d) The frames of steel frame party walls shall have four-hour fire-resistive protection.

(e) The frames of steel frame curtain and panel walls shall have fire protection of the rating specified for such walls in section fourteen hundred and two and in Parts 3 to 12, inclusive.

(f) The frames of steel frame enclosure and fire walls shall have fire protection of the rating specified for the walls in Parts 3 to 13 inclusive and in Part 15.

(g) The steel frames of walls required by this section to be protected against fire shall not be supported upon wood or other combustible material nor upon metal with less protection than is required for such frames.

(h) The frames of steel frame exterior walls and other walls exposed to moisture shall be protected from rusting.

(i) Solid or hollow non-bearing partitions of steel frame and plaster shall have a total thickness not less than one sixtieth the height between lateral supports, nor less than two inches. The plaster of hollow partitions shall be not less than three quarters inch thick. Vertical steel frame members shall be at least equivalent to twenty-four gage steel channels of a depth not less than half the thickness of the partition spaced not over twenty-four inches on centers.

(j) Except as otherwise specified in this section steel frame bearing or non-bearing walls may have frames of unprotected steel and panels of incombustible materials. Steel frame walls, bearing or non-bearing, with panels of combustible materials, may be used only where wooden frame walls are allowed by this code, except that in buildings of Type V, unprotected steel frame walls may have panels containing a layer of combustible insulating material between sheets of steel or equally protective covering.

***Sect. 1417. Wooden Frame Walls.**— (a) Wooden frame walls shall not be used for exterior walls except in buildings of Type VI construction nor for interior bearing walls except in buildings of Type IV or Type VI con-

struction. Wooden frame walls shall not be used for party walls, fire walls, enclosure walls required to have greater than one-hour fire resistance, nor for walls where incombustible materials are specified. Wooden frame walls shall not be used for foundation walls, nor for bearing partitions in basements or cellars.

(b) Non-bearing wooden frame partitions may be used in buildings of Type I, Type II, and Type V, in occupancy of Group F and Group G only, solely for the purpose of sub-dividing space occupied by one tenant, provided that the space so divided shall be separated from any other tenant in the same story by partitions of fire-resistive quality as required by the particular conditions.

Non-bearing wooden stud partitions covered on both sides with three quarter inch thick plaster on incombustible lath may be used in buildings of Type I and Type II for Groups H and J occupancy, solely for the purpose of sub-dividing apartments or similar space occupied by one tenant, provided that such partitions shall not exceed five hundred lineal feet within a single floor area, separated from the rest of the story by partitions of fire-resistive quality as required for the particular conditions.

Nothing in this paragraph shall be construed to allow wooden frame partitions in Type I, Type II, and Type V buildings where fire-resistive partitions of other materials for egress, enclosures or vertical openings, or separations are required elsewhere in this code.

(c) Wooden frame exterior walls shall have posts, sills, and girts not smaller than three and five eighths by five and five eighths inches. When the studs are continuous throughout two stories they shall be of one piece, the girts shall be replaced by a ledger board not less than fifteen sixteenths by five and five eighths inches housed into the studs. Studs shall be no smaller than one and five eighths by three and five eighths inches. Dimensions of members in this paragraph are actual net dimensions.

Posts shall be well braced the full story height, and walls shall be framed to them by a stud-sized brace attached to the post just below the girt and running in the wall at an angle not more than sixty degrees from the vertical, attached at the other end to the girt or sill. These braces shall be horizontally braced at the corner post at least once in each story, and the studs which they intersect shall be well fastened above and below the brace. Posts and girts shall be mortised, tenoned, and pinned at each floor level or connected by approved metal fasteners which provide equal rigidity. The tenons shall be not less than one inch in thickness and the full height of the girt.

Where a ledger board replaced a full girt the space behind the ledger board shall be fire stopped with at least one and five eighths inch lumber cut between the studs. In wooden stud exterior bearing walls more than one story high, the studs shall be not over sixteen inches apart on centers, and shall be bridged at least once at mid-height. In one story walls studs shall be spaced not over twenty inches apart on centers, and need not be bridged. At intersections, between such walls and interior partitions, studs shall be well blocked, making what is commonly known as solid corners. Wall plates shall consist. either

of two layers of wood not less than one and five eighths by three and five eighths inches, each, or of one layer of wood not less than three and five eighths by three and five eighths inches. At openings in bearing walls, studs shall be doubled or have a minimum section of three and five eighths by three and five eighths inches and the heads of openings shall be trussed.

Posts in one and two story walls shall be in one piece — in three stories they may be spliced once in their length, just above the second or third floor girt. Girts and caps may be spliced not oftener than once in twelve feet. Such splices shall be made by halving the piece of wood with a lap of at least eight inches. The lap shall be securely pinned or spiked. In two-piece caps the minimum length of pieces shall be the full length of the wall or twelve feet. Joints shall be broken with at least twelve inches overlap. If studs are spaced farther apart than indicated in this paragraph they shall be classed as wooden columns, girts and caps framing on them shall be classed as wooden beams, and they shall all meet the requirements of section twenty-five hundred and five and twenty-five hundred and six.

(d) Wooden stud bearing partitions shall have studs not less than one and five eighths by three and five eighths inches supported upon a girder or upon a sole plate not less than one and five eighths inches thick. The partition plate shall be not less than one and one half inches thick. Studs of a partition in an upper story over a partition below shall rest upon the plate of the lower partition and not upon the ends of the floor beams. Studs of wooden frame bearing partitions shall be bridged at least once at mid-height and studs supporting a floor shall be not more than sixteen inches apart on centers. Studs shall be doubled beside openings in partitions, and the heads of such openings shall be trussed or framed sufficiently heavy to carry the load. Wooden stud bearing partitions shall not be used to support more than a roof and three floors and in buildings three stories or more in height shall have one-hour fire-resistive rating. If studs are spaced farther apart than indicated in this paragraph, they shall be classed as wooden columns and the caps over them shall be classed as wooden beams and they shall both meet the requirements of sections twenty-five hundred and five and twenty-five hundred and six unless in the category of the following: In one story habitations, where height from sill to plate does not exceed nine feet, the studs may be one and five eighths by two and five eighths inches, plate may be two pieces of one and five eighths by two and five eighths inches or one piece of two and five eighths by three and five eighths inches, sills may be two and five eighths by five and five eighths inches and corner posts may be blocked studs.

(e) Hollow wooden frame walls and partitions shall be firestopped at floor and ceiling levels. Bearing partitions shall be firestopped the full height between ceiling and floor above. Firestopping shall consist of incombustible materials or of wood not less than one and one half inches thick.

(f) Exterior wooden frame bearing walls shall be covered on the outside with wood boarding nailed to the studs or with other approved material equally effective in stiffening the frame of the building. Boards shall be not less than three quarters inch thick unless a weather boarding is used, in which case it shall have an average thickness of at least five eighths inch. Each

board shall have at least two nails to each stud. Stucco, masonry veneer and any material composed principally of gypsum shall not be considered a satisfactory substitute for boarding on exterior wooden frame walls.

(g) Any other style of wall construction which provides stability, rigidity and fire-resistance equal to that of the walls specified in this section, as disclosed in tests prescribed by the commissioner and satisfactorily passed, may be used where wooden frame walls are allowed.

[*As amended by Ord. 1943, ch. 4, Ord. 1953, ch. 7, and Ord. 1955, ch. 2]

PART 15.

PROTECTION OF VERTICAL OPENINGS.

***Section 1501. Protection of Vertical Openings.**— (a) Where an opening in only one floor is required to be enclosed by provisions of Parts 3 to 12, inclusive, or by Part 18, it shall be enclosed either in the story above or in the story below, or protected by a trap door in such manner as to resist the spread of fire from one story to the other. Where a series of openings in two or more floors, required to be enclosed, are enclosed in one shaft, they shall be enclosed in all stories. A required exit shall not be closed by a trap door, except as otherwise provided in Part 18. The exterior walls of buildings are excluded from the provisions of this part, except as specifically provided in section fifteen hundred and three.

(b) Openings in floors which are not provided with trap doors and are not enclosed in the story above, shall be protected by an adequate railing at least thirty inches high. Openings in roofs, unless covered by trap doors or skylights, shall be protected by an adequate railing or parapet at least thirty inches high.

[**As amended by Ord. 1943, ch. 4*]

***Sect. 1502. Trap Doors.**— (a) A trap door in a floor or roof shall be able to support its own weight and a concentrated load of two hundred pounds; and unless protected by a curb not less than six inches high or by a railing, shall be able to support a live load equal to that of the floor or roof in which it is placed. The requirements of this section shall not apply to stage construction in a theatre. A trap door in a floor shall be arranged to close automatically in case of fire in a manner satisfactory to the commissioner.

(b) In buildings of Type I and Type II construction a trap door shall not exceed six feet in either dimension, and shall have fire resistance equivalent to that of a Class A fire door as specified in Part 22.

(c) In buildings of a type of construction other than Type I or Type II, trap doors shall be of the construction required for the floor or roof, except that a trap door in a ceiling required to have fire resistance shall be equivalent in fire resistance to a Class A fire door as specified in Part 22 and shall not exceed six feet in either dimension.

(d) The commissioner may waive in part or modify the requirements of this section for protection of openings less than four square feet in area subject to such conditions as he shall in each case specify.

*Sect. 1503. Enclosure of Vertical Openings.— (a) In buildings of Type I, Type II or Type III construction, the required enclosure of a floor opening shall have two-hour fire-resistive rating.

(b) In buildings of Type IV construction, except as otherwise provided in this section, the required enclosure of a floor opening shall have not less than one-hour fire-resistive rating. In such buildings four stories or more in height and in such buildings three stories in height other than of Group H or Group I occupancy, such enclosures shall also be of incombustible materials. In buildings of Type IV construction more than three stories high an enclosure about both stairs and elevator shall have not less than two-hour fire-resistive rating.

(c) In buildings of Type V construction floor openings, if enclosed, shall be enclosed with incombustible materials.

(d) In buildings of Type VI construction, except as otherwise provided in this section, the enclosure of a floor opening where required, shall have not less than one-hour fire-resistive rating, and this provision shall apply to the inside face of that portion of an exterior wall which forms part of such an enclosure as well as to an interior wall.

(e) Combustible wainscoting, insulating or acoustical material may be attached to the walls of enclosures provided for in this section, but not within the enclosure, as specified in Part 14.

(f) Doorways in enclosures only about passenger elevators shall be protected by Class C fire doors or doors of incombustible materials in which glass shall be wire glass. Doorways in other enclosures of vertical openings shall be protected, in enclosures required to have two-hour fire-resistive rating by Class B fire doors and in enclosures required to have one-hour rating by Class C fire doors, except as otherwise provided in Parts 3 to 12, inclusive. Window openings in required enclosures shall be protected by fire windows. Openings for ventilation in required enclosures shall be protected as provided in section fifteen hundred and five. Other openings in required enclosures shall be protected as the commissioner shall in each case specify.

(g) In required enclosures of floor openings, fire windows shall be fixed or automatic-closing; doors shall be self-closing or automatic-closing, except access doors for repairs which shall be kept closed and locked, and except doors in enclosures only about passenger elevators.

(h) The enclosure of chutes and dumb-waiters not exceeding four square feet in area need not have fire-resistive protection if constructed of metal not thinner than sixteen gauge if in Type I, Type II, or Type V construction. If in Type III, Type IV, or Type VI construction they shall be protected by not less than one-hour fire-resistive enclosure and Class B automatic-closing doors.

(i) Every elevator shaft and stairway enclosure, except dumb-waiter enclosures and enclosures in the interior of a building which do not serve the top story, shall be ventilated at the top by an opening to the outside air not less in area than one per cent of the area of the shaft. In addition, each such shaft shall have at the top means for emergency ventilation in the form

of windows or skylights with thin plain glass, with metal screen beneath, or wire glass, or in other approved form, not less in area than one quarter the area of the shaft.

[**As amended by Ord. 1943, ch. 4*]

Sect. 1504. Floor Construction within Enclosures.— Where the enclosure of floor openings is required by the provisions of Parts 3 to 12, inclusive, or of this part to be of a construction more fire-resistive than the floors of the buildings or where such enclosure is required to be of incombustible materials, any portion of a floor of the building which shall form part of the enclosure, as when the walls thereof are offset, in successive stories, shall be of materials and construction equivalent in fire resistance to that required for the walls.

†Sect. 1505. Openings for Ventilation in Ventilating Shafts.—
(a) Openings for ventilating purposes in enclosures, larger than one square foot in area, except as otherwise provided in this section shall be protected in one of the six following methods:—

(1) Louvres or dampers, which shall close by gravity or be held open by a fusible link so placed as to permit them to close in the case of fire.

(2) Openings into a shaft or duct used exclusively to exhaust the air from two or more stories may be protected by louvres of incombustible material which close by gravity, like a check valve, to prevent reversal of the air current.

(3) Openings into a shaft or duct used exclusively to supply air to two or more stories of a building may be protected by louvres which close by gravity, like a check valve, to prevent reversal of the air current.

(4) Openings in a ventilating shaft, connected with branch ducts at least as long as twelve times the larger transverse dimension of the duct need not have additional protection.

(5) An opening for ventilating exhaust in a shaft enclosure when connected to a duct without openings in other stories, leading to a point above the roof level, need not have the protection of automatic-closing louvres or dampers.

(6) An opening for the supply of air to a ventilated space which is connected by means of a duct without openings in other stories to a fan, plenum chamber or other source of air supply, need not have the protection of automatically closing louvres or dampers.

[*†As amended by Ord. 1943. ch. 4*]

Sect. 1506. Ventilating Ducts.— (a) Ventilating ducts in all buildings shall be of incombustible materials, but may be lined with fibrous insulating or sound deadening material which has been chemically treated, if necessary, so that it will not by itself support combustion. Horizontal offsets of vertical ducts shall be protected in Type I and Type II buildings by at least one-hour fire-resistive construction of incombustible materials.

(b) The combustible material of partitions and floors through which sheet metal ventilating ducts pass shall be kept at least one inch from the metal or be

protected by not less than one half inch of plaster or one quarter inch of asbestos board or other incombustible material of equal insulating value. Openings between sheet metal ventilating ducts and combustible floor construction through which they pass shall be fire stopped with incombustible material.

Sect. 1507. Use of Enclosures. Except as otherwise specifically provided, no limitation is imposed in this chapter upon the shape or size of the enclosure in any story of a vertical opening, but the area within a stairway shall not be used for storage or manufacturing, or within any enclosure for other than the purpose or purposes for which the vertical opening was constructed, but this provision shall not be held to prevent the placing of electrical cabinets, piping, fire extinguishing apparatus and the like, in vertical enclosures in such manner as shall not interfere with its required use. A corridor serving as a passageway to two remote exits from a story shall be separated from such exits, if enclosed, by the enclosure thereof.

PART 16.

FLOOR CONSTRUCTION.

SECTION

Section 1601. Floor Construction.— The floor construction in all buildings shall conform to the requirements of other chapters of this code as to structural design, quality and strength of materials. Floors shall be so constructed as to afford to walls, columns, piers, beams and other supporting members the lateral support which is required for their stability.

***Sect. 1602. Type I: Fireproof Floor Construction.**— (a) In buildings of Type I construction the floors shall be of steel, reinforced concrete, brick or structural clay tile arches, reinforced gypsum, or of combinations of these materials or other approved system of floor construction, and shall be of not less than three-hour fire-resistive construction as provided in Part 22. Floor beams which are spaced not further apart than half the spacing of columns, including in this case those connected to columns, may be considered as a part of the floor and not of the building frame for purposes of this section.

(b) In buildings of Type I construction columns and framing supporting floors, where they are not supported on masonry walls or piers, and such members of the floor framing as are connected to columns or necessary for the stability of columns, except as otherwise provided in this section, shall be of structural steel protected by not less than four-hour fire-resistive protection or of reinforced concrete the reinforcement of which is so protected, except that fire protection need not be provided on steel or iron forms, on lintels not more than six feet in span in bearing masonry walls and not more than ten feet in span in non-bearing masonry walls, on supports for elevator guides and elevator machines except where they support other loads or brace the floor framing, on the metal framing of mezzanine floors which may be of wood as specified in this section, or on the landings of enclosed stairways.

(c) Floors in Type I buildings may be covered with wood or other combustible flooring. Where wooden sleepers are used for laying wooden floors the space between the structural floor and the flooring shall be filled solidly with incombustible material under corridor and permanent partitions and elsewhere on continuous lines for at least a foot in width in such manner that there will be no hollow spaces under the flooring exceeding one thousand square feet

in area. Wooden flooring shall not underlie enclosure or toilet room partitions, nor masonry partitions.

(d) Mezzanine floors in Type I buildings may be of wood or unprotected metal provided there are not more than two such mezzanines in any one room, the total area of the mezzanines does not exceed one third the area of the room or five hundred square feet, and one is not above the other.

(e) The fire protective material required for structural steel shall preferably be applied directly to the metal but structural steel members enclosed in spaces not over five thousand square feet in horizontal area, which are protected above, below and on all sides by ceilings, floors and walls of four-hour fire-resistive construction and are unoccupied and inaccessible except in emergency, need not have other fire protection.

(f) Ceilings in Type I buildings may be finished in wood or other combustible but not highly flammable material for ornamental, insulating, acoustical or similar purposes. Such material, with similar materials on walls and partitions, shall not exceed ten pounds per square foot of floor area enclosed by exterior walls and partitions of two-hour fire-resistive construction, nor a total of five thousand pounds if said floor space is enclosed in exterior walls and partitions of one-hour fire-resistive construction. Such materials shall be backed up by three-quarter inch plaster or equivalent fire-resistive material.

[**As amended by Ord. 1943, ch. 4*]

†**Sect. 1603. Type II: Semi-Fireproof Floor Construction.**—(a) In buildings of Type II construction the floors shall be of incombustible materials and structural metal shall have one-hour fire-resistive protection. Floor beams which are spaced not further apart than half the spacing of columns, including in this case those connected to columns, may be considered as a part of the floor and not of the building frame for purposes of this section.

(b) In buildings of Type II construction columns and framing supporting floors, where they are not supported on masonry walls or piers, and such members of the floor frame as are connected to columns or necessary for the stability of columns, except as otherwise provided in this section, shall be of structural steel protected by not less than two-hour fire-resistive protection or of reinforced concrete the reinforcement of which is so protected, except that fire protection need not be provided on steel or iron forms, on lintels not more than six feet in span in masonry bearing walls and not more than ten feet in span in non-bearing masonry walls, on supports for elevator guides or elevator machines except where they support other loads or brace the floor framing, or on the landings of enclosed stairways.

(c) Floors in Type II buildings may be covered with wood or other combustible flooring as provided in section sixteen hundred and two for Type I buildings.

(d) The fire protective material required for structural steel shall preferably be applied directly to the metal but structural steel members enclosed in spaces not over three thousand square feet in horizontal area, which are protected above, below and on all sides by ceilings, floors and walls of two-hour fire-resistive construction, and are unoccupied and inaccessible except in emergency, need not have other fire protection.

(e) Floor construction which consists of steel or other incombustible beams or joists, spaced not more than the thirty-six inches on centers, supporting a floor of reinforced concrete, steel plate or other incombustible materials, and protected on the under side by an incombustible ceiling of one-hour fire-resistive construction shall be considered as meeting the requirements of this section. Enclosed spaces formed by such a ceiling shall not exceed five hundred square feet in horizontal area within incombustible fire stops of one-hour fire-resistive construction.

(f) Ceilings in Type II buildings may be finished in wood or other combustible but not highly flammable material for ornamental, insulating, acoustical or similar purposes. Such material, with similar materials on walls and partitions, shall not exceed ten pounds per square foot of floor space enclosed with exterior walls, ceilings of three-hour fire-resistive incombustible construction, and partitions of two-hour fire-resistive construction, nor six pounds per square foot of floor space enclosed by exterior walls and partitions of one-hour fire-resistive incombustible construction or a total of three thousand pounds. Such material shall be backed up by three quarters inch plaster or equivalent fire-resistive material.

[†*As amended by Ord. 1943, ch. 4*]

Sect. 1604. Type III: Heavy Timber Floor Construction.—(a) In buildings of Type III construction the floor planking, if of wood, shall be not less than one and five eighths inches thick, tongued and grooved or splined, and fire-stopped by a continuous layer of asbestos fabric or other approved fire-resistive material, covered with wooden flooring not less than three quarters inch thick, or equivalent protective flooring. Enclosed or concealed spaces shall be avoided.

(b) Laminated floor construction consisting of lumber not less than one and one half inches nor more than three inches thick placed on edge, and securely spiked together, making a floor not less than three and one half inches thick, may be used in place of planking.

(c) Floor beams in buildings of Type III construction, except as otherwise provided in this section, shall be of structural timber not less than five inches in least dimension nor less than forty square inches in cross-sectional area, but this limitation shall not apply to nailing strips supported on masonry, structural steel or the like.

(d) Columns supporting floors in buildings of Type III construction shall be of structural timber not less than seven inches in least dimensions or of steel protected as specified in this section. Column caps for the support of beams and girders shall be of cast iron, steel or reinforced concrete, except that wooden bolsters may be used on columns supporting not more than a roof and one floor. Columns shall not rest upon the ends of wooden beams. Wood shall not be used for columns in basements or cellars.

(e) The metal of steel column caps or of stirrups supporting beams or girders shall not be thinner than three sixteenths inch nor shall that of cast iron caps be thinner than one half inch.

(f) Timbers supported on masonry walls shall be bevelled so that they may fall free of the wall in case of fire.

(g) Structural steel I-beams or columns of H section may be used instead of timber provided they are fireproofed by filling the space between flanges solidly with concrete or masonry held in place by ties through or secured to the web, or by enclosing the exposed faces in one-hour fire-resistive protection. Other structural steel shapes may be used for beams or columns, protected by one-hour fire-resistive protection. Standard weight steel pipe filled with concrete may be used for columns in buildings of Type III construction.

(h) Floors shall be anchored to exterior and bearing walls and the beams thereof shall be connected to form continuous ties from wall to wall sufficient to resist the wind pressure specified in Part 23 applied outwardly to the walls.

(i) Structural masonry and reinforced concrete shall not be supported upon wooden floor constructions, but this restriction shall not apply to fire-stopping, the protective foundations under heat-producing apparatus or to tile or concrete flooring with its base not more than four inches in total thickness, laid upon the planking.

*Sect. 1605. **Type IV: Light Wooden Floor Construction.**—(a) In buildings of Type IV construction the floors may be of wood unprotected against fire. Floor beams and joists of wood shall not be less than one and five eighths inches thick. Where joists frame on a girder or bearing partition on both sides thereof, the spaces between the joists shall be fire-stopped with incombustible materials or with wood not less than one and one half inches thick.

(b) Floors may be supported upon the masonry walls of the building or upon wooden columns or bearing partitions. Structural steel beams, steel or iron columns without protection against fire, reinforced concrete or other approved materials may be used in the floor framing or for its support. Wood shall not be used for columns or bearing partitions in basements or cellars.

(c) Timbers supported on masonry walls shall be bevelled so that they may fall free of the wall in case of fire.

(d) Floors shall be anchored to exterior and bearing walls and the beams thereof shall be connected to form continuous ties from wall to wall sufficient to resist the wind pressure specified in Part 23 applied outwardly to the walls.

(e) Structural masonry and reinforced concrete shall not be supported upon wooden floor construction, but this restriction shall not apply to fire-stopping, the protective foundations under heat-producing apparatus or to tile or concrete flooring with its base not more than four inches in total thickness, laid upon the boarding.

[**As amended by Ord. 1943, ch. 4*]

Sect. 1606. **Type V: Metal Frame Floor Construction.**—In buildings of Type V construction the floors shall be constructed of incombustible materials. Structural steel or iron floor plates, structural steel beams, or steel or iron columns supporting floors need not be protected against fire.

Sect. 1607. **Type VI: Wooden Frame Floor Construction.**—(a) In buildings of Type VI construction the floors may be of wood unprotected against fire. Floor beams and joists of wood shall be not less than one and

five eighths inches thick. Where joists frame on a girder or bearing partition on both sides thereof, the spaces between the joists shall be fire-stopped with incombustible materials or with wood not less than one and one half inches thick.

(b) Floors may be supported upon the walls of the building or upon wooden columns or bearing partitions. Structural steel beams or steel or iron columns without protection against fire, reinforced concrete or other approved materials may be used in the floor framing or for its support. Wood shall not be used for columns or bearing partitions in a basement or cellar.

(c) Structural masonry and reinforced concrete shall not be supported upon wooden floor construction, but this restriction shall not apply to fire-stopping, the protective foundations under heat-producing apparatus or to tile or concrete flooring with its base not more than four inches in total thickness, laid upon the under boarding.

Sect. 1608. Ratproofing.—(a) Every basement or cellar in buildings hereafter erected shall be completely covered with a ratproof floor of concrete, or solid masonry laid in cement mortar, not less than two inches thick, or other approved flooring. Pits or openings in such floors shall be lined on all sides and the bottom with similar material.

(b) Recesses and inaccessible spaces where rats might find refuge and breed shall be avoided if possible, and otherwise shall be sealed with masonry or with substantial wire mesh of incorrodible metal.

PART 17.

ROOF CONSTRUCTION AND COVERING.

*Section 1701. Roof Construction.—(a) Except as otherwise provided in this part, in so far as they are pertinent, the provisions of Part 16 for the construction of floors and their supports shall also apply to the construction of roofs of buildings of the respective types of construction.

(b) Members of structural steel frames of roofs and other incombustible roof construction covered with fire-retardant roofing, on Type I and Type II buildings, over rooms of Group B occupancy and over approved rooms of Group G occupancy shall be deemed to be sufficiently protected against fire if they are not less than twenty-five feet distant from the floor, and from a mezzanine floor or balcony below; or if they are not less than eighteen feet so distant and are protected by an incombustible ceiling of one-hour fire-resistive construction suspended at least one inch below the steel. Proximity within these limiting distances of an inclined or stepped balcony with fixed seats, of a mezzanine floor or level balcony not more than five feet wide, shall not be grounds for requiring greater fire protection than is required in this paragraph. The ceilings of such rooms and the walls more than five feet above the floor shall not be covered or finished with combustible material.

(c) Filling for drainage on the roof of a building of Type I, Type II and Type V construction shall be of incombustible material except that wood, in amount not more than two board feet per square foot, may be used on a roof of Type I or Type II construction designed for a future floor. Filling for thermal insulation may be of combustible but not highly flammable material laid without air space.

(d) In buildings of Type III the roof planking, if of wood, shall be not less than one and one half inches thick. Wooden columns supporting a roof in a building of Type III construction shall be not less than five inches in least dimension.

(e) In buildings of Type III, Type IV and Type VI construction where the exterior wall is required by Parts 3 to 12, inclusive, to be of fire-resistive construction without unprotected openings, wooden joists, rafters and other combustible roof construction shall not extend through or across the exterior wall, except the roof boarding, planking or a nailing piece, which shall then be covered with metal. Such walls shall extend up to the under side of the roof boarding or planking and where required by Parts 3 to 12, inclusive, to be of four-hour fire-resistive construction without openings, shall have parapets above the roof as specified in Part 14. Where such walls may have

unprotected openings combustible roof construction may project not more than one foot to form eaves except in the first and second fire zones.

[**As amended by Ord. 1943, ch. 5*]

Sect. 1702. Roof Covering.— Roof covering on buildings of Type I, Type II or Type V shall be either fire-retardant or ordinary roofings as specified in Part 22. Roof covering on buildings of Type III, Type IV or Type VI shall be fire-retardant.

Sect. 1703. Roof Drainage.— (a) Roofs of buildings and of all parts thereof shall be sloped to drain at a pitch of not less than one inch in ten feet. Gutters and conductors or leaders shall be provided at the low points to which water will flow, except on one story or two story buildings not over six hundred and fifty square feet in area, with drains to lead away and satisfactorily to dispose of rain water. Means shall be provided to prevent rain water from any part of a building except window sills, copings and cornices not more than one foot wide and awnings or marquises discharging off the outer edge, from filling or flowing upon a public way.

(b) Where a roof is finished with a smooth surface of tile, terrazzo or similar material and under other favorable circumstances, the commissioner may waive the requirement of a slope and permit construction of a level roof subject to such conditions as he shall in any case specify.

(c) No part of any roof shall be so constructed as to discharge snow or ice upon a public way.

(d) Rain water leaders shall not be discharged upon a public way nor upon land of another owner, nor so as to flow upon such public way or land.

(e) This section shall not be held to prevent the construction of a spray pond on a roof or the use of a roof to contain water for industrial or other approved purposes provided it is not allowed to become stagnant.

PART 18.

EXITS.

SECTION

Section 1801. General Requirements for Exits.— Every new building and every portion thereof shall have exits in conformity with this part and Parts 3 to 12, inclusive. No building shall be enlarged, altered or repaired in such manner as to reduce the number or capacity of exits to less than required nor shall the occupancy be changed unless the exits conform or are made to conform to the requirements for the new occupancy.

Sect. 1802. Kinds of Exits.— (a) An exit from a room may be either —

(1) A doorway.
(2) A window.
(3) An exit from a story.

(b) An exit from a story may be either —

(1) An interior stairway.
(2) An interior ramp.
(3) A smokeproof tower.
(4) An exterior stairway or ramp.
(5) A fire escape.
(6) A ladder.
(7) Elevators.
(8) An exit from the building or from the fire division.

(c) An exit from a building or from the fire division may be either —

(1) A doorway in the exterior wall of the building opening upon a street or an open space with access to a street.

(2) A horizontal exit.

(d) All exits shall be of the kinds listed in the preceding paragraphs of this section subject to the limitations and requirements of this part, except that where two exits are required the commissioner may permit the substitution for one of them of sliding poles, chutes or other means of egress when all the persons who may in emergency need to use such means of egress are trained to their use in their daily occupations and when all other relevant conditions are satisfactory to the commissioner.

(e) No exit of any kind may serve as a required exit unless it is or forms part of a continuous path of exit from the floor space served to the street.

(f) At least one exit from every story of a building, except a basement, cellar, first or second story from which there is a doorway exit to a street or to an open space accessible to a street, shall be an interior stairway, an interior ramp or a smokeproof tower.

***Sect. 1803. Number of Occupancies.**— (a) The number of persons to be served by an exit shall be stated in the application for permit and shall be computed from the floor area on the following basis:

(1) One person for every six square feet in auditoriums, assembly halls, dance halls, gymnasiums, armories, lodge rooms.

(2) One person for every fifteen square feet in court rooms, restaurants, retail stores, class rooms in schools.

(3) One person for every twenty-five square feet in lodging houses, reading rooms.

(4) One person for every thirty-five square feet in factories and work rooms.

(5) One person for every fifty square feet in offices and show rooms.

(6) One person for every one hundred square feet in Group D buildings, hotels, apartments and other dwellings, police and fire stations.

(7) One person for every two hundred square feet in automobile repair shops and service rooms, museums, libraries, wholesale stores, and club-houses, except in assembly halls thereof.

(8) One person for every thousand square feet in storage garages and warehouses.

(b) For other occupancies the commissioner shall determine the ratio of occupants to floor area in each case.

(c) Where the kind or width of an exit depends upon the number of persons served by it, such number shall be determined by dividing the maximum number of persons in any room or group of rooms, or in any story and within a fire division, by the number of alternative exits to which they all have access less one (assuming that one such exit may be blocked) except where only one exit is required.

[**As amended by Ord. 1943, ch. 5*]

†Sect. 1804. Number and Location of Exits.—(a) Except as otherwise specified in Parts 3 to 12, inclusive, buildings and parts thereof shall have at least the number of exits required in this section. The kinds of exits pro-

vided, as required in this part, shall be subject to the limitations imposed by sections eighteen hundred and five to eighteen hundred and sixteen inclusive.

(b) Every room and group of less than four rooms shall have at least one exit conforming to the requirements of this chapter. The exit from an attic or similar enclosed space, accessible but normally unoccupied, may be a scuttle not less than two feet by three feet in the ceiling of the story below. Such scuttle shall, if required by the commissioner, be provided with a paermanent ladder. The flat roof of a building, if occupied by persons, shall be considered a room and a story for the purposes of this section.

(c) Every room or group of rooms containing in the aggregate more than twenty-five hundred square feet of floor area or seventy-five occupants and every group of our or more rooms, except an attic or similar enclosed space accessible but normally unoccupied, shall have at least two remote exits. Such exits may open into a common corridor which has at least two remote exits. Closets, vestibules, toilet rooms and the like shall not be counted as rooms of a group for the purpose of this paragraph.

(d) When a story of a building is occupied by two or more tenants, each tenant shall have access to at least two remote exits from the story.

(e) Every story in a building shall have at least two remote exits except:

(1) Stories above the first story in single family dwellings less than three stories in height.

(2) A basement or cellar constructed large enough for low pressure heating apparatus and its fuel storage only, requiring attendance of not more than two persons.

(f) Every room or story required to have two remote exists shall have two remote and independent paths of exit of the required width at all points.

(g) A single exit from a room or group of rooms which has no other exit shall not be further than sixty feet from any point within the room or rooms measured along the path of exit.

(h) Where two or more exits from a room are required they shall be remote or distant from one another in such manner that persons in any place may choose either of two directions in a path toward an exit, and in such a manner that a single fire in its early stages cannot block both paths toward an exit. The distance from any point in a room to the nearest exit, except as specifically indicated in special group requirements, shall not exceed one hundred and fifty feet in buildings of Type I, Type II and Type V nor seventy-five feet in buildings of Type III, Type IV and Type VI.

(i) The exits from astory in a fire division shall be of such number and so located that at least one such exit is within one hundred and fifty feet in buildings of Type I, Type II and Type V, and within severy-five feet in buildings of Type III, Type IV and Type VI, from every exit from a room or group of rooms into a corridor or, in a story without a corridor, from every point within the story and fire division, except as specifically indicated in special group requirements. The distance to an exit, if a doorway, shall be

measured to the nearer jamb thereof; if an enclosed stairway or ramp, to the doorway in the enclosure; and if a stairway or ramp not enclosed, to the nearest point of the top riser or commencement of slope.

[†*As amended by Ord. 1943, ch. 5*]

***Sect. 1805. Corridors and Passageways.— (a)** A passageway shall be provided and maintained in every story of a building from all parts of the floor to the required exits, of width not less than the required width of the exit to which each leads, nor less than twelve inches for every one hundred persons served.

(b) Corridors may serve as exits from the doorways from rooms to exits from the story. The clear exit width of corridors shall be not less than the required width of any doorway from which it leads, nor of the exit to which it leads, nor less than thirty-six inches nor less than twelve inches for every one hundred persons served.

(c) Neither radiators nor pipes, doors in an open position nor any other equipment or construction shall be allowed to reduce or encroach upon the required width of a corridor. If lockers are placed along one or both sides of a corridor its clear width between lockers shall be increased over its required exit width by eighteen inches for each side on which lockers are placed and if other use than egress and lockers is made of corridors, the clear width shall similarly be increased over its required exit width as the commissioner shall in each case determine.

(d) Passageways which serve as exits from enclosed stairways or ramps to exits from the building shall be enclosed corridors except where they may occur in a building which is not over forty feet wide and of a total area not exceeding two thousand square feet. In such a building one of the enclosed corridors in the first floor only may be omitted provided the basement and first story are equipped with automatic sprinklers and the class of construction is Type IV or more fire-resistant.

(e) The clear width of such passageways shall be not less than required for the stairway or ramp nor less than twelve inches for every one hundred persons in any story of the building served. The clear height shall be not less than seventy-eight inches.

(f) The floor and walls of a corridor serving as an exit from an enclosed stairway or ramp shall have fire-resistance of the rating required for the enclosure and the ceiling shall be of one-hour fire-resistive construction.

(g) The floor of such a corridor shall be level or shall slope not over one vertical in ten horizontal, but such floor shall be level for a distance of forty-four inches from a stairway and at all doorways or connecting corridors for the full width thereof and one foot additional on each side.

(h) An outside passageway leading from an exit from a building to a street shall have the clear width required for an interior passageway, and if covered shall be covered by incombustible construction. Such passageway shall be subject to all pertinent requirements for exits.

[**As amended by Ord. 1943, ch. 5*]

†**Sect. 1806. Doorways as Exits.— (a)** Doorways which serve as required exits shall be not less than twenty-four inches wide. Doorways which serve as exits for more than ten persons shall be not less than seventy-eight inches high nor less than thirty inches wide nor less than twelve inches in width for every hundred persons so served.

(b) The floor both sides of a doorway exit shall be at the same level for

a distance of three feet in either direction from the doorway, except that in doorway exits from a building to the outside there may be a single step-down not over six inches to a level landing not less than three feet wide.

(c) Thresholds in exit doorways shall not be over one inch high.

(d) In enclosures of stairways or ramps which serve as required exits, doors shall swing in the direction of egress.

(e) Except in buildings of Group I, swinging doors in doorways which serve as required exits from the building shall swing in the direction of egress.

(f) Revolving doors shall be of an approved type, without cable or bar braces, designed and constructed to release when simultaneous outward forces are exerted by persons of ordinary strength on both sides of the pivot so that the wings will fold back on themselves like the leaves of a book in the direction of egress. The use of revolving doors shall be limited as follows:

(1) They shall not be used in occupancies of Group A, Group B, Group C, and Group D.

(2) They may be used in other group occupancies only if swinging doors immediately adjacent to them provide seventy-five per cent of the required egress.

(3) They shall not be used in any exit from premises where alcoholic beverages are sold for consumption on the premises.

(g) Except in detention buildings, doors in required exits shall not be so locked or fastened that they cannot be opened from the inside without use of a key.

[†*As amended by Ord. 1943, ch. 5*]

Sect. 1807. Windows as Exits.— A window shall not serve as an exit except in an existing building and in such case only as the second of two required exits serving not more than ten persons and subject to the approval of the commissioner and to such conditions as he may in each case prescribe. This provision shall not be held to limit the use of glass in a door.

‡Sect. 1808. Interior Stairway.— (a) Interior stairways may serve as exits from any story of a building. Except as otherwise provided in this section, every interior stairway required to be enclosed shall have a direct doorway exit from the building or shall have an enclosed corridor leading to such exit, except as provided in paragraph (d) of Section 1805.

(b) In buildings more than three stories high with flat roofs at least one interior stairway or ramp shall extend to the roof; and where more than two stairways or ramps serve as required exits, at least two shall be interior stairways or ramps which shall extend to the roof. In such buildings more than three hundred feet long there shall be at least two remote stairways or ramps extending to the roof. In a two-story or three-story building with flat roof, unless a stairway extends to the roof, there shall be a scuttle in the roof, not less than two feet by three feet, with a ladder, near a stairway.

(c) An interior stairway shall be located entirely within the exterior walls of a building, but this requirement shall not be held to constrain the shape or plan of the exterior walls or the construction of the enclosure wall.

(d) No interior stairway serving as a required exit shall be less than thirty inches wide except a single flight stairway to a balcony serving not more

than ten persons which may be not less than twenty-four inches wide. No stairway serving as a required exit for ten or more persons shall be less than thirty-six inches wide nor less than twelve inches additional for every one hundred persons so served in excess of three hundred. The clear vertical headroom over each riser shall be not less than six feet six inches.

(e) Interior stairways shall be enclosed where so required in Parts 3 to 12, inclusive, and in Part 15 of this code.

(f) In buildings of Type I, Type II or Type V interior stairs, including landings, which serve required exits shall be constructed of incombustible materials, except that stairs with solid treads, risers and landings of incombustible materials may have top surfaces of wood, linoleum or other similarly combustible material. Treads, risers or landings of marble, slate or similarly brittle material shall be backed with sheet steel, for stairs three feet or less in width of at least number twelve gage, and for wider stairs at least number ten gage. Cast iron shall have a thickness of at least three sixteenths inch in treads and risers and three eighths inch in landings. Cast iron landings shall not have greater area than nine square feet between steel or other supports. Enclosed metal stairs and landings need not be protected against fire. Stairs which are not enclosed as provided in Part 15, in buildings of Type I or Type II shall have protection against fire as specified for floors.

(g) In buildings of Type III, Type IV or Type VI not over three stories high, stairs, including landings, may be of wood. In buildings of Type III wooden stairs which are not enclosed as provided in Part 15 shall have treads at least one and one half inches thick; the risers, if any, shall be one and one half inches thick; stringers shall be not less than three and one half inches in least dimension; and the stairs shall be constructed without concealed spaces. Wooden stairs with soffits enclosed by plaster, sheathing or otherwise, shall be fire-stopped at floors and landings and not further apart than at every eighth riser with incombustible material or with wood not less than one and one half inches thick.

(h) Treads and risers of stairs serving as required exits, except in schools, shall be so proportioned that the product of the tread and the rise in inches shall be not less than seventy nor more than seventy-seven; and the treads shall not be less than nine and one half inches nor the rise more than seven and three quarters inches. In schools, the treads and risers may be proportioned, with the approval of the commissioner, to suit the age of the pupils. Treads and risers shall be uniform throughout any one flight.

(i) No flight of stairs shall have more than fifteen nor less than two risers between landings. A landing between two flights of stairs in the same direction shall be at least as wide as the stairs and at least three feet long in the direction of travel. Stairs turning at a right angle shall have a square or rectangular landing the full width of the respective stairways. Where stairs return directly on themselves, a landing without steps shall be provided at least as wide as the stairs.

(j) Spiral stairs shall not be used in a stairway serving as a required exit for ten persons or more nor in stairways more than one story in height, except in a single family dwelling; and in pre-code buildings with the approval of

the commissioner. Stairs may be curved if the tread and rise one foot from the inner rail are as specified in this section.

(k) Where stairs and landings are not guarded at the side by a wall or partition, they shall have a railing, balustrade, grille or similar guard at least thirty-three inches high at the face of the riser. In case a stairway more than two stories high has recurring flights and landings, about an interior well more than twelve inches wide in horizontal projection, the guard next the well shall be not less than three feet high at the face of the riser, and shall consist, if a railing, of at least two rails, if a balustrade, of balusters not over six inches apart, and if a grille or other form of guard, of meshes not more than six inches in least dimension, and the edge of the stairs and of the landings shall have a curb at least three inches high.

(l) Stairs less than forty-four inches wide shall have a handrail on one side; stairs forty-four inches wide or more and curved stairs shall have handrails on both sides. Where the width of a stairway is required, as an exit, to exceed eighty-eight inches one or more intermediate handrails shall be provided not over eighty-eight inches apart. Handrails shall be about three feet high above the center of the treads, shall be continuous between landings and in stairways which serve as required exits, handrails which are not continuous shall be returned at the upper end to the wall or terminate at a post in such manner as not to leave a free or projecting end. Handrails may be of wood.

(m) No pipe, radiator or other equipment shall obstruct or encroach upon the required width of a stairway or landing. No stairway which serves as a required exit shall be obstructed while the building is occupied, within the enclosure thereof, on the steps or landings or on the floors within the area required for exit or for approach to the stairway, by materials, equipment or by any use of such space except for passage.

(n) There shall be no closet within the required enclosure of a stairway. There shall be no closet for storage under a stairway of combustible material which is a required exit except a coat closet in dwellings or a toilet or similarly non-hazardous use, and in such case the soffit of the stairway shall be protected by a ceiling of one-hour fire-resistive construction.

[‡*As amended by Ord. 1943. ch. 5*]

***Sect. 1809. Interior Ramps.**—(a) Interior ramps may serve as exits from any story of a building.

(b) An interior ramp shall be located entirely within the exterior walls of a building.

(c) The width, enclosure, guarding and construction of ramps shall be the same as provided for interior stairways. All requirements for interior stairways which are pertinent shall also apply to interior ramps except the requirement for handrails.

(d) Ramps which serve as required exits shall not have a slope greater than one vertical in ten horizontal.

[**As amended by Ord. 1943, ch. 5*]

***Sect. 1810. Smokeproof Towers.**—Smokeproof towers, if built, may serve as required exits from any story of a building. Interior stairways constructed and arranged as follows shall be known as smokeproof or fire towers.

(a) The enclosed walls of fire towers shall be of incombustible materials or assemblies having a fire-resistive rating of at least four hours. Such walls shall be without openings, except for doors serving as means of egress.

(b) At each story served by a fire tower access to the stairways of such fire tower shall be provided through outside balconies or fire-proof vestibules. Such balconies or vestibules shall be at least three feet eight inches in width and shall have unpierced floors of incombustible materials and shall be provided with substantial guard rails at least four feet high, without any openings greater than eight inches in width.

(c) Such balconies or vestibules of fire towers shall be level with the floors of the structure and the platforms of the stairs connected by such balconies. Such balconies or vestibules shall be separated from the structure and the stairs by self-closing fire doors capable of being opened from both sides without the use of a key, except the final balcony or vestibule as described in paragraph (d) which may open only from one side without the use of a key.

(d) Balconies or vestibules of fire towers shall open on a street or yard or on a court open vertically to the sky for its full height, having a minimum net area of one hundred and five square feet and a minimum dimension of seven feet. The opening from the vestibule to the street, yard or court shall have a minimum area of eighteen square feet and a minimum dimension of two feet six inches. It shall be unlawful to leave openings in the court walls surrounding an interior fire tower other than the openings from the vestibules, within fifteen feet of the balcony, except that self-closing fire windows may be used if such windows are at least ten feet from the balcony, provided that the area of the court is at least twelve feet by twenty-four feet.

(e) Fire towers shall terminate at the grade level and shall exit directly to the street independently of corridors serving other stairways except when the fire tower terminates in the ground floor corridor outside of the inner vestibule and within ten feet of the building line.

(f) Doors opening into fire towers may be constructed with observation panels made of polished wire glass, one-quarter of an inch thick, if such glass is set with a three-quarter inch rabbet. Such glass shall have a maximum area of sixteen square inches. Doors shall be capable of being opened from both sides without the use of a key. A handrail shall be provided on both sides.

[**As amended by Ord. 1943, ch. 5*]

Sect. 1811. Exterior Stairways or Ramps.—(a) Exterior stairways or ramps may serve as required exits from any story or stories of a building. Except as to enclosure and location within the exterior walls of a building, an exterior stairway or ramp shall conform to the requirements for interior stairways or ramps, respectively. Exterior stairways or ramps shall be located outside the exterior walls of a building, but not nearer than five feet from a lot line other than a street line.

(b) Exterior stairways or ramps serving as required exits, and their land

ings, railings and enclosures, if any, shall be of incombustible materials except on buildings of Type VI construction and except that handrails may be of wood.

(c) A doorway serving as an exit from a story to an exterior stairway or ramp shall open upon a landing level with or not more than one six-inch step below the floor, and shall be protected except in buildings of Type VI construction by a self-closing Class B fire door. Openings for doorways or windows under or within five feet from an exterior stairway or ramp, except in buildings of Type VI construction, shall be protected by automatic-closing Class B fire doors or fire windows, unless the exterior stairway or ramp is enclosed in one-hour fire-resistive construction.

(d) Except where guarded on the side by the exterior wall of the building, or by an enclosing wall, an exterior stairway or ramp more than three stories or thirty feet above the ground shall be guarded by a railing, balustrade or grille not less than six feet high with openings not more than six inches wide.

***Sect. 1812. Fire Escapes.**— (a) Fire escapes shall not be erected to serve as required exits except as follows:—

(1) From pre-code buildings where ordered by the commissioner under the provisions of Section 16 of Part I.

(2) From post-code buildings four stories or less in height and five thousand square feet or less in area.

(3) Where ladders may serve as exits.

(4) As emergency exits from buildings of Group A or Group B occupancy as provided in Parts 3 and 4, and

(5) Where ordered by the commissioner under the provisions of section sixteen of Part 1.

(b) Fire escape landings and stairs shall have a clear exit width of not less than twenty-four inches where the maximum number of persons to be served does not exceed one hundred and forty-four, and an additional one inch in width shall be added for each additional six persons served, excepting therefrom emergency exits as required in Group A and Group B.

(c) Fire escapes shall be of incombustible materials.

(d) The floors of fire escape balconies or landings, if of steel, shall be of open construction with steel bars not over one half inch nor less than one quarter inch wide and spaces not over one and one quarter inches each nor less in the aggregate than two thirds the floor area. The bars shall be rigidly spaced near their ends and at intervals not exceeding two feet. Floors shall be securely attached to supports.

(e) Fire escape stairs, if steeper than is allowed for interior stairs, shall not be steeper than necessary, nor in any event steeper than sixty degrees with the horizontal. Stairs steeper than sixty degrees shall be deemed ladders and shall not be used for exits except where ladders are allowed. The product of the tread and rise in inches shall be not greater than seventy-seven and the rise shall not exceed nine inches. The construction of the tread shall be as required for landing floors, if of steel, and not less than seven and one-half inches wide. Treads shall be securely attached to stringers. There shall not be less than three nor more than fifteen risers between landings.

(f) The sides and ends of fire escape landings and the sides of stairs, where not guarded by a wall, shall have a railing at least three feet high, consisting of a bar not less than one and one half by three eighths inch and a balustrade of half-inch round bars or equivalent with a lower rail. The railing shall be supported by posts and shall be sufficient to withstand safely a lateral force of twenty pounds per foot of rail, and in Group H and Group I shall have one-half inch round bar palings not over six inches from center to center.

(g) Openings for doorways or windows under or within five feet from a fire escape, except in buildings of Type VI construction, shall be protected by automatic-closing Class B fire doors or fire windows, unless in the case of show windows or other windows the commissioner modifies this requirement in consideration of other specific provisions contributing to safe egress over the fire escape in question.

(h) Fire escapes shall not be bracketed from masonry walls more than five times the thickness of the wall. Bracketed cantilevers shall be bolted through the wall with plate washers set in mortar on the inside.

(i) Except in the webs of structural channels and I-beams, and in the recticular or cross bars of factory-assembled floor gratings approved as flooring for fire escapes, the steel in fire escapes shall not be thinner than one quarter inch nor shall bolts be less than three eighths inch. Stove bolts shall not be used. If stringers of stairs are spliced, the splice shall be made by riveting or welding, and not by bolting.

(j) The lowest run of fire escape stairs may be hinged near the top to swing up into a horizontal position when not in use. Such runs shall be counter-balanced but not so heavily that they will fail to lower by gravity when released. The hinge shall consist of a single round bar, not less than seven eighths inch diameter, with approved bearings on both stringers of the lower run and properly supported. The hinge bar shall be not less than two inches horizontally back from the nosing of the stair tread under which it is placed. The hinged run shall be held in horizontal position by a bent bar at least seven eighths inch in diameter, rigidly held in bearings and bent across the stairway above the hinged run in such manner that a person using the fire escape for egress must release the hinged run before reaching it, or by other approved device.

[**As amended by Ord. 1943, ch. 5*]

†**Sect. 1813. Ladders as Exits.** — (a) Ladders shall not serve as exits except where specifically allowed in this part and in Parts 3 to 12, inclusive. A ladder not more than one story high may serve as exit where a scuttle is allowed.

(b) Ladders serving as exits shall be permanently fixed in place and shall be not over fifteen feet in length. In buildings of Type I, Type II and Type V, ladder exits shall be incombustible. Rungs shall be uniformly spaced, not over twelve inches top to top, and shall be supported by two rails not less than twelve inches apart.

[*†As amended by Ord. 1943, ch. 5*

***Sect. 1814. Elevators as Exits.** — (a) Elevators may serve as exits from stories of buildings where all the following requirements are complied with, namely: —

(1) There are at least two other remote exits from the stories conforming with the provisions of Section 1804 and not less than three feet six inches wide.

(2) The elevators shall be passenger elevators, not less than two in number enclosed in a single shaft or in adjoining shafts. The elevators shall have capacity to evacuate the occupants of any floor in five trips each

(3) The elevators shall be in operation and in charge of licensed operators during usual business hours and when the building is occupied.

(4) The elevators shall have a lobby outside their enclosure in each story served by the elevators with a floor area of at least two square feet for every occupant in the story, separated from the occupied area of the story by partitions of not less than one-hour fire-resistive construction. Vertical openings within such lobbies shall be enclosed in all stories in which they occur. Corridor space contiguous to the lobby shall be considered a part of the lobby.

(5) In buildings of Type III or Type IV construction, the enclosure of lobbies in successive stories shall be continuous, forming a complete one-hour separation as specified in Part 13, through all stories.

(b) Elevators serving as exits shall have sufficient speed to make a round trip from first story to top and back without intermediate stops in two minutes

[**As amended by Ord. 1943, ch. 5*]

Sect. 1815. Horizontal Exits. — (a) A horizontal exit shall consist of a doorway in an exterior or party wall of a building or in a fire wall separating two fire divisions of a building, which leads to a story, in another building or fire division, at the same or approximately the same level, from which egress may be made.

(b) A horizontal exit may serve as an exit from a room, from a story or from a building, but not from the interior stairway or ramp required in paragraph (f) of section eighteen hundred and two.

(c) The clear floor area in the story in the building or fire division to which a horizontal exit leads shall be sufficient to contain the occupants of the story in both buildings or fire-divisions allowing three square feet for each person.

(d) A horizontal exit shall have at least the width required for it as an exit, or for the exits which it serves as outlet.

(e) Where the floors connected by a horizontal exit are at different levels a ramp shall be provided the full width of the exit sloping not over one vertical in ten horizontal, with guard railing on the open sides.

(f) The doorway of a horizontal exit in an exterior wall of a building may lead to an adjoining or nearby building by means of a connecting balcony or bridge or by a tunnel, at least as wide as the doorway. The floor of such balcony or bridge, except as provided in paragraph (g) of this section, shall be solid of Type I construction, and shall be level with, or not more than one six-inch step down from, the floors with which it connects. The floor of such a balcony, bridge or tunnel shall be horizontal or have a slope not exceeding

one vertical in ten horizontal, and shall not contain steps or stairs except with the approval of the commissioner. Unless the balcony or bridge is enclosed in one-hour fire-resistive incombustible construction, doorways or windows opening on or under, or within five feet from such balcony or bridge, shall have automatic-closing Class B fire doors or fire windows. The open sides of such balcony or bridge shall be guarded as required for the landings of exterior stairways.

(g) Connecting balconies of fire escape construction may be used for horizontal exits only where fire escapes are permitted.

Sect. 1816. Other Exits.— Sliding poles, chutes or other devices provided as means of egress shall conform in all respects to such requirements as the commissioner shall in any case prescribe.

Sect. 1817. Exit Enclosures.— (a) Interior stairways and ramps shall be enclosed as specified in Parts 3 to 12, inclusive, and in Part 15.

(b) Interior stairways and ramps which serve as required exits from stories above the second story shall be enclosed, except as otherwise provided in Parts 3 to 12, inclusive, in all stories in which they occur.

(c) Doors in a stair enclosure shall be automatic or self-closing and shall never be locked against egress except in detention buildings. Such doors shall swing in the direction of egress and shall not in any position reduce the width of the stairway or its landings below that which is required.

Sect. 1818. Exit Signs.— Required exits, except in buildings of Group I, Division 1, shall be marked by suitable signs sufficiently illuminated to be easily read when the building is occupied. If exits are located where they would not be expected to be found, directing signs shall be provided as they may be required by the commissioner.

Sect. 1819. Exit Maintenance and Lighting.— (a) Required stairways, passageways, corridors and other exits shall be at all times maintained in safe condition, and when the building is occupied, shall be kept clear of obstructions and ready for use.

(b) Outside stairs and fire escapes and the vestibules of smokeproof towers shall be cleared promptly of ice or snow. Awnings shall not be permitted to interfere with fire escapes.

(c) Required stairways, passageways, corridors and other exits, interior or exterior, except in single-family dwellings and within apartments or suites of buildings of Group H and Group I, shall be kept adequately lighted when the building is occupied, or shall be provided with approved means for lighting which can be turned on by an occupant at a convenient point or points.

PART 19.

DOORS, WINDOWS AND SKYLIGHTS.

***Section 1901. Doors.**— (a) Doors in doorways which serve as required exits shall conform to the requirements of Part 18.

(b) Doorways in enclosures of vertical openings shall have doors which conform to the requirements of Part 15.

(c) Doorways in required separations between two units of occupancy or between two fire divisions of a building shall have doors which conform to the requirements of Part 13.

(1) Except where otherwise specified in this code, doorways in walls required to have one-hour resistance to the spread of fire shall have doors which, if of wood, shall be not less than one and one half inches thick in any part. Such doors, if not of wood, or if larger than twenty-five square feet in area, shall be Class C fire doors.

(2) Except where otherwise specified in this code, doorways in walls required to have two-hour resistance to the spread of fire shall be automatic-closing Class B fire doors.

(3) Except where otherwise specified in this code, doorways and other openings in walls required to have three-hour resistance to the spread of fire shall have automatic-closing Class B fire doors on both sides of the wall. The sum of the areas of such openings in one story shall not exceed one-half the area of the sum of said walls and no single opening shall be greater in area than two hundred square feet.

(4) Doorways and other openings in party walls and, except where otherwise specified in this code, in walls required to have four-hour resistance to the spread of fire, shall have automatic-closing Class A fire doors on both sides of the wall. The sum of the areas of such openings in one story shall not exceed one-half of the sum of the areas of said party walls and no single opening shall be greater in area than one hundred square feet.

(5) In the protection of openings less than two square feet in area in fire-resistive walls, the commissioner may waive in part or modify the requirements of this section subject to such conditions as he shall in each case specify.

(6) In doorways required to have specified width and height a stop moulding forming a rabbet of the frame may project on each side and at the top not more than three-quarters of an inch inside the required dimen-

sions. The door, in open position, shall clear the required width of the doorway completely and the door and frame shall have additional width if necessary for this purpose.

(7) Doors required to be automatic-closing shall be self-closing and normally closed, or equipped to close automatically by the action of heat in the event of fire.

[**As amended by Ord. 1943, ch. 5*]

†**Sect. 1902. Windows.**— (a) Fire windows shall conform to the requirements of Part 22.

(b) Windows in exterior walls of buildings shall conform to the requirements of Parts 3 to 12, inclusive, and Parts 14 and 20.

(c) Windows in enclosures of vertical openings shall conform to the requirements of Part 15.

(d) Windows in required separations between two units of occupancy or between two fire divisions of a building shall conform to the requirements of Part 13.

(e) Windows in other walls and partitions required to have resistance to the spread of fire shall be fire windows.

(f) In walls and partitions the openings of which are required to have the protection of fire doors, a fixed fire window may be considered equivalent to one Class B fire door, but two such windows shall not be substituted as equivalent to two doors in an opening where two fire doors are required.

(g) In the exterior walls of buildings of approved occupancy and construction the commissioner may allow the substitution of an approved system of open sprinklers and ordinary windows for the fire windows specified in this section.

(h) Windows in exterior walls of elevator shafts shall be protected by vertical metal bars not less than five eighths inch in diameter, outside the sash, forming spaces not more than ten inches wide, firmly secured in the opening.

(i) Openings in cellar and basement walls shall have effective protection against the passage of rats.

(j) In display windows fronting on a public way, in the first story of a building, a bulkhead may be constructed which shall be of the same type of construction as the first floor. Where the first floor is continuous to the exterior wall without opening, a platform of wood or other combustible material may be built to form the raised floor of the display space. In display windows, fronting on a public way, not more than two stories high, the back, sides and ceiling of the display space, shelves, partitions and the like, and entrance vestibules and doorways in connection with such display windows, may be of wood or other combustible but not highly flammable material; provided, that this paragraph shall not be construed to allow a vertical opening in any floor without the enclosure specified in Part 15.

[*†As amended by Ord. 1943, ch. 5*]

‡**Sect. 1903. Skylights.**— (a) Except on greenhouses skylights shall be of incombustible materials.

(b) Except on greenhouses, and except over photographic studios with the approval of the commissioner, skylights shall be glazed with wire glass or shall be protected by wire screens. Such screens shall be of at least No. 12 gage wire with not larger than one-inch mesh, on substantial metal supports, at least six inches but not more than twelve inches above the glass and parallel thereto, and projecting at least six inches beyond the edge of the skylight.

(c) Skylights over stairways and corridors, except in buildings of Group I, and skylights over restaurants, halls and other public rooms, shall be glazed with wire glass or protected by a wire screen or a ceiling light of wire glass below.

(d) Skylights, except the glass thereof, shall be designed to support the loads provided in Part 23 for roofs of corresponding slope.

(e) The parts of skylights exposed to the weather, gutters for leakage or condensation, outside screens and their supports if of metal, shall be of metal protected against corrosion.

[‡*As amended by Ord. 1943, ch. 5*]

Sect. 1904. Sidewalk Lights.— Glass units of approved shape, size and thickness may be set in reinforced concrete roofs, floors or sidewalks, with or without metal shields, in a manner approved by the commissioner. Screen protection shall not be required above or below such construction except where specifically required by the commissioner.

PART 20.

PENTHOUSES AND ROOF STRUCTURES.

***Section 2001. Height of Buildings.**— (a) Limitation, wherever it occurs in this code, upon the height of buildings measured to the highest point of the roof thereof shall not be held to limit the height of the steeples of churches, towers, domes, cupolas, belfries, parapets, or other walls, cornices, statuary, balustrades, railings, flag poles, weather-vanes, chimneys, vent pipes, skylights, ventilators, steam exhausts, tanks, signs and penthouses for the enclosure of tanks, stairways, elevator machinery, ventilating fans and the like, erected upon or above the roof of a building, provided such structures shall not be occupied by persons nor be used for storage or for a manufacturing process requiring constant or frequent attendance.

(b) The provisions of this part shall not be held to authorize construction of any kind above the limit of height specified for every part of a building in section one hundred and thirty-six of Part 1 of this code.

(c) The limitation of height of buildings contained in Parts 3 to 12, inclusive, of this code and the provisions of this part shall not be held to prohibit the use of the open roof of a building, nor the laying of suitable flooring over the roof covering, which conforms with the provisions of this code for the type of construction of the building.

[**As amended by Ord. 1943, ch. 5*]

Sect. 2002. Penthouses.— (a) Penthouses enclosing elevator machinery, ventilating fans, tanks, elevators, stairways and the like shall not be larger than reasonably necessary for their purpose, including the storage of tools, spare parts, appliances and materials necessary for the maintenance and repair of such equipment.

(b) Penthouses on buildings of Type I or Type II construction shall be of incombustible materials and the walls and roofs thereof shall afford protection against fire outside of one-hour fire-resistive construction. Doors and windows in such walls shall be Class C fire doors or fire windows.

(c) Penthouses on buildings of Type V construction shall be of incombustible materials including the doors and windows thereof.

(d) Penthouses on buildings of Type III, Type IV or Type VI shall be of the same type of construction as the building and the walls thereof may be constructed as provided in this code for partitions, covered on the outside by metal, cement plaster on metal lath or equally fire-retardant covering.

(e) The wall of a penthouse which rests upon the exterior wall of a building shall conform to the requirements of this code for an exterior wall.

(f) Except where used as provided for in paragraph (a) of this section, a penthouse upon the roof of a building shall be considered an additional story or additional stories of the building and shall conform to the requirements therefor. The provisions of this section shall not be held to limit the construction of such additional stories.

Sect. 2003. Roof Structures.— (a) The walls of dormers shall be constructed as specified in this code either for the exterior walls or for the roof of the building on which they are built.

(b) Where persons occupy or use the open roof of a building, such roof or the portion so occupied shall be guarded by a parapet wall or approved fence or railing not less than forty-two inches high.

(c) Except as otherwise provided in this part, and except flag poles and water tanks, all structures erected on the roof of a building shall be of incombustible materials.

PART 21.

CHIMNEYS AND HEATING APPARATUS.

*Section 2101. Support of Chimneys.— (a) A chimney shall support no vertical load except its own weight, but this provision shall not apply to masonry bonded to a chimney outside the required thickness thereof, nor shall it be held to forbid a suspended staging for erection or maintenance. An independent or free-standing chimney shall be stable and shall support its weight and resist the force of the wind without exceeding the stresses allowed by this code for the materials of which it is constructed.

(b) Unless corbelled from a masonry wall, a chimney shall be supported upon a foundation of masonry or reinforced concrete conforming to the provisions of Part 29, upon the furnace which it serves, if of masonry and capable of supporting the chimney, or upon primary framing of Type I or Type II construction.

(c) No chimney shall be corbelled from a masonry wall more than the thickness of the wall nor from a wall less than twelve inches thick.

[**As amended by Ord. 1943, ch. 5*]

Sect. 2102. Chimney Construction.— (a) The walls of chimneys shall be of brick, stone, cast stone, concrete blocks, structural clay tile or plain or reinforced concrete, with such lining as is specified in this section.

(b) For the purposes of this part the lining of a chimney flue shall mean the material forming the inner surface of the flue, whether the remainder of the chimney wall is (1) integral with the lining, (2) additional thickness of similar material or (3) of different materials. Except as otherwise specified in paragraph (i) of this section, the lining of every flue in a chimney shall be of burned clay or shale brick not less than three and one half inches thick of

A or B quality as specified in Part 24, or of refractory material as specified in this section. The lining of every chimney flue more than two hundred and fifty-six square inches in area of cross-section shall be of refractory material from a point not less than twice the inside diameter of the chimney (the larger diameter if rectangular) below the bottom of the smoke pipe entrance, or from the bottom of the flue, to a point not less than six times such inside diameter above the top of the smoke pipe entrance. Refractory material shall consist of burned fire clay flue lining not less than five eighths inch thick, fire brick not less than three and one half inches thick, or radial hollow clay chimney tile, made of suitable refractory clay capable of withstanding the heat and corrosive effect of flue gases and having a softening point not lower than nineteen hundred degrees Fahrenheit. In such a chimney mounted upon a masonry furnace the required refractory flue lining shall be continuous with the lining of the furnace and shall extend not less than six times the inside diameter of the flue above the top of the furnace.

(c) Burned fire clay flue linings shall be built in as the masonry of the chimney is laid. All joints and spaces between the masonry and lining shall be thoroughly filled with mortar as each course of the masonry is laid. Cracked, broken or otherwise defective flue lining shall not be used in a chimney. Fire brick or radial tile lining shall be laid in fire clay or with narrow beds and joints of mortar. Burned clay or shale brick lining shall be laid in mortar or fire clay. Brick or radial tile lining may be separated from the chimney wall provided the wall outside the lining is not less than eight inches thick, and both wall and lining are independently stable.

(d) Not more than three flues of burned fire clay flue lining may be laid contiguous in a chimney nor shall the aggregate width of such contiguous flues exceed thirty-seven inches without separating masonry withes at least four inches thick bonded to the walls of the chimney. Walls of brick between two flues in a chimney shall be not less than three and one half inches thick.

(e) The masonry wall of a chimney outside the flue lining shall be not less than four inches thick. In chimneys of radial hollow clay chimney tile in which wall and lining are integral the total wall thickness shall not be less than six inches.

(f) Stone masonry of sawed or dressed stone in courses, well bonded at corners and tied with anchors of non-corrodible metal shall be not less than four inches thick outside the flue lining. Chimney walls of other stone masonry shall be not less than twelve inches thick outside the flue lining.

(g) Concrete block masonry shall not be used in an independent or free-standing chimney nor in chimneys bonded to walls more than three stories in height.

(h) Structural clay load-bearing tile of A grade, as specified in Part 24, may be used in the walls of chimneys, or radial hollow clay chimney tile of equivalent quality. Other hollow clay tile shall not be used. Units shall be so laid that the ends of cells are not exposed.

(i) Chimneys of concrete cast in place shall be reinforced for shrinkage and temperature stresses. Concrete integral with the chimney wall shall be considered satisfactory flue lining in such chimneys above a point thirty feet above the smoke entrance, and in flues less than one hundred and forty-four

square inches in area in buildings of Group I, Division 1, provided the concrete walls are not less than six inches thick and the concrete is proportioned for a strength of two thousand pounds per square inch as specified in Part 26.

(j) Chimneys shall have a coping at the top for protection of the masonry from the weather.

Sect. 2103. Chimney Height.—(a) Chimneys shall be carried to a height sufficient to protect adjoining buildings from fire and smoke and unless the roof is covered with incombustible material, shall extend at least thirty inches above the highest point of intersection with the roof.

(b) Chimney flues shall have a well below the entrance of the lowest smoke pipe and shall be provided with a metal cleanout door with built-in frame.

***Sect. 2104. Wood near a Chimney.**—(a) No chimney shall be built nearer than one inch from wooden floor or roof joists or nearer than one inch from wooden studding, furring or other woodwork. The space about a chimney shall be fire-stopped at each floor and ceiling level with incombustible material, unless such space is treated as a vertical opening and is enclosed as provided in Part 15.

(b) In case wooden beams or other woodwork are supported on a masonry wall or pier bonded to a chimney, such woodwork shall not be nearer than four inches from the chimney. For the purposes of this section a chimney shall consist of the flue or flues, the lining, if any, and the walls to the required thickness.

[**As amended by Ord. 1943, ch. 5*]

†Sect. 2105. Smokestacks.—(a) A smokestack shall support no vertical load other than its own weight, but this shall not be held to forbid a suspended staging for erection or maintenance. A smokestack exposed to the force of the wind shall be capable of resisting such force and support its own weight without exceeding the stresses allowed by this code for the materials of which it is constructed.

(b) A smokestack shall be supported by incombustible construction or by the construction supporting the furnace which it serves, but in buildings of wooder construction a stack may be stayed laterally by incombustible stays to the wooden construction. A smokestack may be mounted directly upon and supported by the boiler or furnace which it serves if such boiler or furnace is designed and constructed to support safely the weight thereof.

(c) The metal of a circular steel or sheet iron smokestack shall have not less than the following thickness:—

Diameter of Stack.	Thickness.
Not more than 16 inches	No. 10 Gage
More than 16, not over 24 inches	No. 8 Gage
More than 24, not over 30 inches	3/16 inch
More than 30, not over 48 inches	1/4 inch
More than 48, not over 60 inches	5/16 inch

(d) A smokestack may be mounted on the outside of a building supported by and secured to the exterior wall thereof. If the wall is of combustible materials the stack shall be not less than four inches and not less than one third the stack diameter away and the wall for a width not less than twice the diameter of the stack shall be covered by one quarter inch of asbestos and sheet metal, or approved equivalent.

(e) A smokestack inside a building shall be protected from contact with goods or persons by a substantial shield of incombustible materials, with provision for ventilating the space between stack and shield. If a smoke stack is within a ventilating shaft or other enclosure of a vertical opening, provision shall be made for ventilating the shaft or enclosure at the bottom and above the roof. Such enclosure shall be of incombustible materials and the stack shall stand clear of the enclosing walls on all sides.

(f) A smokestack shall have at least four inches clearance from combustible material; such material within twelve inches of the stack shall be covered by one quarter inch asbestos and sheet metal or its approved equivalent and the space about the stack shall be ventilated.

(g) Pertinent provisions for chimneys shall apply also to smokestacks.

[†*As amended by Ord. 1943, ch. 5*]

‡**Sect. 2106. Smoke Pipes.**— (a) Smoke pipes of metal shall be not less than number twenty-four gage copper-bearing, black or galvanized sheet iron, except that where gas is used for fuel, sheet copper weighing not less than sixteen ounces per square foot, or other approved material may be used.

(b) Smoke pipes, where they connect with a chimney, shall be tightly fitted in a burned fire clay, cast iron or other substantial thimble built into the masonry, or a smooth-sided opening of brick or other masonry.

(c) Smoke pipes of unprotected metal shall not be nearer than eighteen inches below exposed combustible construction unless the combustible material is protected by an incombustible shield having a width equal to twice the diameter of the pipe, suspended at least three inches below such combustible material and three inches above the pipe and ventilated on both sides. The space between a metal smoke pipe covered with not less than one and one half inches of asbestos or other approved insulation and combustible material above, or between a smoke pipe of unprotected metal and woodwork above protected by a ceiling of one-hour fire-resistive rating shall be not less than three inches.

(d) Metal smoke pipes shall be at least twelve inches horizontally from combustible material unless protection and clearance are provided as specified in paragraph (c) of this section.

(e) If a masonry flue connects a furnace with a chimney or a stack, it shall be lined and otherwise constructed as specified for a chimney.

[‡*As amended by Ord. 1943, ch. 5*]

***Sect. 2107. Fireplaces.**— (a) Fireplace walls shall be not less than eight inches thick and if built of stone or hollow units shall be not less than twelve inches thick. The faces of such walls exposed to fire shall be lined with fire brick or other suitable fire-resistive material. When lined with four

inches of fire brick such lining may be included in the required minimum thickness. Every fireplace shall be connected to a chimney flue built as specified in section twenty-one hundred and two.

(b) Fireplaces shall have hearths supported by trimmer arches or other approved fire-resistive construction. Trimmer arches and hearths shall be not less than twenty inches wide measured from the face of the chimney breast and shall extend not less than twelve inches beyond the fireplace opening on each side. Trimmer arches shall be of brick, stone or hollow tile not less than four inches thick, shall spring from the masonry supporting the fireplace and may thrust against the floor frame whether of wood or other material. A flat stone or reinforced concrete slab may be used to support a hearth instead of an arch if it is properly supported and a suitable fill provided between it and the hearth. Hearths shall be of brick, stone, tile or concrete. Wood centering under a trimmer arch shall be removed after the masonry has thoroughly set. No combustible materials shall be placed within three inches from the jambs or from the top or arch of a fireplace opening.

(c) No heater burning solid or liquid fuel shall be placed in a fireplace which does not conform with the requirements of this section. The provisions of this section shall not be held to prevent construction without flue of a suitable foundation and wall protection, resembling a fire place for a gas-burning space heater; but if such construction has a flue, it shall conform in all respects to the provisions of this section for a fireplace.

(d) Each fireplace shall have a separate and independent flue throughout its length to the open air.

[**As amended by Ord. 1943, ch. 5*]

Sect. 2108. High Pressure Boilers.—(a) Boilers generating steam at a pressure in excess of fifteen pounds per square inch shall be so located that no combustible material shall be less than two feet from the top or sides or ten feet from the front; and all combustible material less than four feet from the top or sides shall be protected by incombustible construction of at least one-hour fire-resistive rating and shall be well ventilated to prevent the temperature from rising above two hundred and fifty degrees Fahrenheit.

(b) Steel, cast iron or reinforced concrete columns adjacent to such boilers, except columns which support only the boilers, shall not be in direct contact with boiler settings but there shall be an open and unobstructed space at east four inches wide for ventilation.

Sect. 2109. Low Pressure Boilers.— Boilers generating steam at a pressure not over fifteen pounds per square inch, and hot water heaters not including domestic water supply heaters, shall have clearance from wooden partitions, ceiling and other combustible material, the same as specified for hot air furnaces in section twenty-one hundred and ten.

†**Sect. 2110. Hot Air Furnaces.**—(a) Hot air furnaces shall be encased in a metal or masonry shield with an air space between shield and fire box. Unless the shield over the top is double with an air space, the top of the furnace shall be covered with approved insulating material one inch thick.

(b) Combustible material placed within seven feet from a hot air furnace at the front or within two feet at the sides or rear shall be protected by sheet metal, or asbestos board, and if such material is within one foot from such furnace at the sides or rear, it shall be protected in the manner required in section twenty-one hundred and six for woodwork near a metal smoke pipe. The distance from the top of a hot air furnace to exposed combustible material above, within two feet laterally from such furnace and four feet in front, shall be not less than eighteen inches unless such woodwork is protected as provided in section twenty-one hundred and six for combustible material above a metal smoke pipe.

[†*As amended by Ord. 1943, ch. 5*]

‡**Sect. 2111. Hot Air Pipes and Registers.**—(a) Horizontal hot air furnace pipes shall be placed at least six inches below combustible material except that if such material is protected by metal lath and plaster or a loose-fitting metal shield or if the hot air pipe is covered with one half inch of corrugated asbestos insulation, the clear distance may be reduced to three inches for portions of pipes within five feet from the furnace and to one inch for more distant pipes.

(b) Hot air pipes passing through combustible partitions or floors either shall be double sheet metal pipes with at least one half inch air space or be covered with asbestos paper weighing not less than sixteen pounds per one hundred square feet.

(c) No hot air pipes shall be placed in a wooden stud partition or wooden enclosure unless it is at least five feet horizontally from its outlet on the furnace. Hot air pipes in combustible partitions either shall be double with one half inch air space, or the space shall be lined with sheet metal or other incombustible material, or the pipe shall be covered securely with asbestos paper weighing not less than sixteen pounds per one hundred square feet. Hot air pipes in closets shall be not less than one inch away from woodwork or be double pipe with one half inch air space or be covered with asbestos paper weighing not less than sixteen pounds per one hundred square feet.

(d) Every hot air furnace shall have at least one hot air pipe and register without damper, valve or louvres.

(e) Where a register in the floor directly over a furnace is connected by a pipe from the top thereof, such pipe shall be double with not less than one inch ventilated air space and no combustible material shall be within three inches from the inner pipe.

(f) Hot air registers placed in woodwork shall be surrounded with borders of incombustible material which shall prevent the register from coming in contact therewith.

(g) Register boxes for warm air in wooden floors or partitions shall be made of sheet metal, double, with at least one half inch air space or shall be kept at least one half inch from woodwork and covered with asbestos paper weighing not less than sixteen pounds per one hundred square feet.

(h) The provisions of this section shall not apply to hot air pipes and registers from indirect low pressure steam or hot water radiators.

[‡*As amended by Ord. 1943, ch. 5*]

***Sect. 2112. Water Heaters and Hot Plates.**— (a) Gas or electric domestic water supply heaters and gas or electric hot plates shall not be nearer than seven inches from a combustible wall unless the combustible material in the wall is protected by two inches clearance and sheet metal or its approved equivalent extending at least nine inches beyond each side and two feet above the apparatus. Wooden ceiling or shelving shall not be less than three feet above such apparatus.

(b) Gas hot plates and electric hot plates or appliances of more than eighteen hundred watts capacity shall not be placed upon a wooden shelf or counter unless the appliance has a solid metal floor under the burners or heating elements, raised not less than two inches above the shelf, and the shelf is protected with sheet metal; or unless equivalent approved protection is provided.

[**As amended by Ord. 1943, ch. 5*]

†Sect. 2113. Domestic Stoves and Ranges.— (a) Insulated or uninsulated stoves and ranges not of the flushback type used for heating rooms, water, or for the cooking or laundry of a family, whether burning solid, liquid, gaseous fuel or electricity shall not be placed within seven inches from a combustible wall. No wood or other combustible materials forming shelves, ceiling, cabinets or fixed furnishings shall be installed less than three feet above the top of stove or range or the uppermost oven of either, or within seven inches of the sides of ranges or stoves. Where incombustible materials are used for shelving — ceiling, cabinets or fixed furnishings — the minimum clearance above the top of range, stove or uppermost oven of either shall be eighteen inches and from the sides of range or stove, four inches.

(b) Insulated Flushback Type Ranges or stoves may be placed directly against existing or new partitions, walls or other structure providing the entire wall, partition or structure is composed wholly of incombustible materials. Arrangement of shelving, cabinets, ceiling and fixed furnishings shall be as mentioned in paragraph (a) of this section.

(c) Combustion chambers of stoves or ranges burning solid or liquid fuel shall be connected to a chimney or a smokestack. Ovens and hoods of stoves and ranges may be ventilated to a chimney, smokestack, or ventilating duct. Such connections shall be of metal not less than number twenty-six gage thickness and wherever they pass through construction of combustible material they shall be encased in a sleeve of approved type which provides a clearance of at least three-fourths of an inch from any combustible material.

[*†As amended by Ord. 1943, ch. 5*]

Sect. 2114. Commercial Stoves and Ranges.— (a) Stoves and ranges such as are used in kitchens of restaurants, hotels, clubs and similar establishments shall not be placed nearer than twenty-four inches from a combustible wall unless the combustible material in the wall is protected by six inches clearance, not less than one-hour fire-resistive construction and a shield of metal or other approved incombustible material with free circulation of air between it and the wall, extending at least twenty-four inches beyond each side of the range and four feet above the top.

(b) Such stoves and ranges shall be provided with hoods of incombustible material connected by pipe or duct with an independent chimney flue or smoke stack extending above the roof. The hood, if of sheet metal or other similarly thin material, shall be separated from combustible material above by at least nine inches clearance, or by a ceiling of one-hour fire-resistive construction. The connecting pipe or duct shall be separated from combustible material as specified for smoke pipes in section twenty-one hundred and six, with one half the clearances there specified.

Sect. 2115. Oil Burners.— Oil burners shall be installed in accordance with chapter one hundred and forty-eight of the General Laws and regulations issued thereunder.

Sect. 2116. Incinerators.— (a) All incinerators, except those not exceeding four square feet in grate area, shall be constructed of brick masonry or reinforced concrete. The walls and roof shall be at least eight inches thick; if the area of the combustion chamber is fifteen square feet or more, the walls and roof shall be at least twelve inches thick.

(b) The combustion chamber above the grate, and both above and below the grate in down-draft incinerators, shall be lined with fire brick laid in mortar or fire clay or with equally fire-resistive material. Fire brick lining may be included in the required wall and roof thickness.

(c) If the smoke flue is used as a refuse chute, it shall be a smooth-lined chimney, vertical and directly over the combustion chamber. Charging hoppers shall be of approved design and construction and shall not project within the flue area. The area of charging opening shall not exceed one third the flue area nor shall the least dimension of the flue be less than three times the vertical dimension of the charging hopper. The top of the chimney shall be covered with a cage or screen of non-corrodible metal of approved design, and having an area not less than twice the flue area.

Sect. 2117. Support of Heat Producing Apparatus.— (a) Except as otherwise provided in this section, heat producing apparatus whether electrical or by the combustion of solid, liquid or gaseous fuel shall be supported upon a substantial foundation of incombustible and heat-resistive materials laid on the ground, or upon a floor of Type I construction.

(b) Electrical appliances of less than eighteen hundred watts capacity shall not be subject to the requirements of this section.

(c) Domestic stoves and ranges used for heating one room or for the cooking or laundry of one family, gas or electric water supply heaters, and heaters burning solid or liquid fuel for the domestic hot water supply of one family, may be supported upon floors of Type II or Type V construction with incombustible flooring. Such apparatus may be supported upon a wooden floor or combustible flooring, either;—

(1) Where the apparatus has solid metal construction under the heating elements, fire or burners and ovens, not less than six inches above the floor and, except under gas or electric apparatus, with free circulation of air over the floor; or

(2) Where the floor is protected by sheet metal under and extending at least six inches beyond the sides and rear and at least twelve inches beyond the front of the apparatus and at least four inches of solid brick masonry or concrete under the apparatus; or with equivalent approved protection.

(d) Stoves, ranges and coal or oil burning water supply heaters, for restaurants, hotels, clubs and similar establishments may be supported upon Type II or Type V construction with incombustible flooring, when the apparatus has solid metal construction under the fire, burners or other heating elements and ovens, raised on metal legs not less than four inches above the floor with free circulation of air between. Such apparatus may be supported upon a wooden floor or combustible flooring, either;—

(1) Where the apparatus has solid metal construction under the fire, burners, or other heating elements and ovens, raised on metal legs not less than four inches above the floor with free circulation of air between, and the floor is protected with non-corrodible sheet metal under and extending at least six inches beyond the sides, rear and front of the apparatus and a baffle sheet of one half inch asbestos secured between two sheets of non-corrodible sheet metal under the entire apparatus suspended two inches below the floor thereof; or

(2) Where the floor is protected by non-corrodible sheet metal under and extending at least six inches beyond the sides, rear and front of the apparatus, and hollow construction, under the apparatus, of brick on edge not less than four nor more than twelve inches apart, topped by reinforced concrete not less than three inches thick; or by equivalent approved protection.

(e) Heating apparatus such as down-draft and oil burning furnaces in which the floor of the combustion chamber rests directly upon a reinforced concrete or other structural floor, shall have a heat-resistive foundation, with ventilation and insulation if necessary, to prevent injury to structural metal or other materials in the floor.

(f) Under boilers, furnaces and other heat-producing apparatus supported upon a floor required by the provisions of Part 29 to be waterproofed, shall be installed insulation equivalent to that required for a wooden floor, to protect the waterproofing against damage from heat.

Sect. 2118. Smoke Connection.— Every apparatus for the generation of heat by the combustion of fuel shall have suitable connection to an adequate chimney or smokestack except gas appliances exempted by the regulations for gas fitting issued under section one hundred and sixteen of Part 1 of this code and other small apparatus of similarly intermittent use burning oil and generating not over twenty thousand British thermal units per hour, and except such apparatus in foundries, forge shops and similar establishments as shall be exempted with the approval of the commissioner.

***Sect. 2119. Other Heat Producing Apparatus.**— Other heat producing apparatus such as bake ovens, coffee roasting ovens, core ovens, japanning ovens, rendering furnaces, stereotype furnaces, wood-drying kilns,

annealing furnaces, charcoal furnaces, galvanizing furnaces, gas producers, smoke houses, forges and the like, shall be supported, and nearby woodwork and other combustible material shall be protected from such apparatus in the manner specified in this chapter for apparatus of similar size, temperature, and character of heat exposure. These and other special or uncommon sources of heat and flame shall be so constructed and protected as to prevent heating any wood or other combustible material used in the construction of floors, ceilings, partitions or other parts of a building, or required waterproofing, to a temperature over two hundred and fifty degrees Fahrenheit, when in full operation, and shall be so constructed as not to be liable to undue corrosion or deterioration or to accidental overturn or other disarrangement conducive to danger.

Every application for such permit shall be in writing, shall be filed with the commissioner and shall set forth the character of the building, the size, power and purpose of the apparatus, and such other information as the commissioner may require. The commissioner may, after an examination of the premises described in the application, and after hearing the applicant and any objectors, issue a permit for placing this apparatus on such premises, upon such conditions as he shall prescribe, or he may refuse such permit. If the application is for anything other than a boiler or furnace the applicant shall publish in at least two daily newspapers published in the city of Boston, and on at least three days in each, and if so directed by the commissioner, shall also post conspicuously on the premises a copy of the application, and shall deliver copies thereof to such persons as the commissioner may designate.

If no objection is filed with the commissioner before the expiration of ten days after the time of the first publication of notice, or within ten days of the delivery and first posting of the notice, if such delivery or posting is required the commissioner shall if the arrangement, location and construction of the proposed apparatus is proper and in accordance with the provisions of this act, issue a permit for the same. If objection is filed the application shall be referred to the board of appeal which may in its discretion require the deposit by the objector of a reasonable sum as security for the payment of the costs.

After such notice as the board shall order it shall hear the same and shall direct the commissioner to issue a permit under such conditions as it may prescribe, or to withhold the same. If the permit is refused, the applicant and if it is granted the objectors shall pay such cost as the board may order.

The commissioner may, from time to time, after public notice and hearing, prescribe the conditions on which furnaces, boilers, or other steam generator and hot water heaters may be maintained in buildings, and, if any person interested objects to such conditions and appeals from his decision establishing the same, the appeal shall be referred to the board of appeal, and thereupon said board shall prescribe the conditions.

[**As amended by Ord. 1943, ch. 5*]

PART 22.

FIRE-RESISTIVE CONSTRUCTION.

***Section 2201. Determination of Fire-Resistance.**— (a) Materials of construction and fire-protective materials, and assemblies or combinations thereof, shall be classified for fire-protective and fire-resistive purposes in terms of their performance in authoritative tests made in accordance with Standard Specifications for Fire Tests of Building Construction and Materials of the American Society for Testing Materials, hereinafter called the Standard Fire Test.

(b) The materials, assemblies and combinations of materials specified and listed in this chapter shall be assumed to have the fire-resistive rating here given. Other materials, assemblies and combinations shall be given fire-resistive ratings by the commissioner. Such ratings shall be determined by reasonable interpolation among the materials, assemblies and combinations listed and rated in this chapter, and by authenticated evidence of performance in standard fire tests, with such margin of safety as he shall consider necessary to provide for the exigencies of commercial production and field construction.

(c) Where the interior of a building of Type III construction is of incombustible construction protected to provide one-hour fire-resistive rating, the exterior walls may be of two-hour fire-resistive construction.

(d) Where the interior of a building of Type IV construction is of incombustible construction, the exterior walls may be of two-hour fire-resistive construction.

(e) In such group occupancies and where Type VI is allowed, but in no case over two stories in height, Type IV buildings may be constructed with their frames and exterior walls of incombustible construction.

(f) All construction referred to in paragraphs (c), (d), and (e) shall be subject to the structural requirements of other parts of this code.

[**As amended by Ord. 1943, ch. 6*]

†**Sect. 2202.—Fire-Resistive Materials and Construction.**—(a) Materials, to be given the fire-resistive ratings specified in this part, shall have the following minimum qualities:—

(1) Concrete of Class 1 shall be so proportioned, in accordance with Part 26, as to have a strength of at least fifteen hundred pounds per square inch and the coarse aggregate shall consist of limestone, trap rock, blast furnace slag, cinders containing not more than twenty per cent of combustible material, burned clay or shale.

(2) Concrete of Class 2 shall be so proportioned, in accordance with Part 26, as to have a strength of at least fifteen hundred pounds per square inch, the coarse aggregate consisting of sandstone, granite, quartzite, siliceous gravel or other similar material not over one inch in size.

(3) Masonry shall consist of the materials specified in Part 24 laid in lime-cement or cement mortar, or approved masonry cement mortar, except that masonry of gypsum tile shall, and masonry of structural clay tile may, be laid in gypsum mortar. Masonry shall be thoroughly bonded by breaking joints in successive courses or by the use of metal ties.

(4) Brick shall be burned clay or shale, concrete or sand-lime brick of Grade C or better as specified in Part 24.

(5) Stone shall be limestone, marble, slate or equally fire-resistive natural stone. Sandstone, granite or other stone which, because of its crystalline structure or for other reason, is less fire-resistive, shall not be considered fire-protection for structural metal, but may be used in a masonry wall not less than twelve inches thick required to have fire-resistance. Stone masonry shall have the same fire-resistive rating as brick masonry.

(6) Cast stone shall conform to the requirements of Part 24. Cast stone masonry shall have the same fire-resistive rating as brick masonry.

(7) Concrete blocks, whether solid or hollow, shall have as coarse aggregate limestone, trap rock, blast furnace slag, cinders containing not more than twenty per cent of combustible material, burned clay or shale, and shall otherwise conform to the requirements of Part 24.

(8) Structural clay tile shall conform to the specifications for load-bearing tile, floor tile or partition tile of Part 24. Where partition tile is specified, load-bearing tile may be used.

(9) Gypsum tile or pre-cast gypsum concrete, whether solid or hollow, shall conform to Standard Specifications for Gypsum Partition Tile or Block of the American Society for Testing Materials and shall not contain more than three per cent by weight of wood or other combustible binder or filler.

(10) Gypsum concrete shall not contain more than twelve and one-half per cent by weight of wood or other combustible binder or filler, and shall have a compressive strength of at least five hundred pounds per square inch as provided in Part 27. It shall not be used where exposed to the elements.

(11) Expanded metal or wire lath as a base or reinforcement for plastering shall weigh not less than two and two tenths pounds per square yard and shall have not less than two and one half meshes per inch.

(12) Metal mesh reinforcement specified for masonry fire protection of structural metal shall consist of wire lath strips the full thickness of the masonry, laid in the beds thereof, or its approved equivalent.

(13) Metal mesh reinforcement specified for concrete fire protection of structural metal shall consist of wire mesh weighing not less than one and one half pounds per square yard with wire spaced not over four inches, or not less than number eleven gage steel wire spaced not over four inches apart, or its approved equivalent.

(14) Cement plaster shall be proportioned of one part Portland cement, and not more than two parts of sand measured by volume dry and loose to which may be added lime putty or hydrated lime not exceeding fifteen per cent of the cement.

(15) Gypsum plaster, except where otherwise specified, may contain sand not in excess of three times the weight of the gypsum.

(16) Lime plaster shall consist of a mixture of one part lime, not over three parts sand, and water.

(17) Pneumatically projected mortar made of Portland cement, sand and water shall be rated for fire-protection the same as Class 1 concrete.

(18) Concrete fill, where specified in this chapter in connection with hollow masonry units, shall consist of Class 1 or Class 2 concrete poured in the hollow spaces of the units as they are laid.

(b) Portland cement concrete or gypsum concrete poured in place as fire-protection for beams, trusses and other horizontal or inclined members of structural steel and pneumatically projected mortar applied to structural steel as fire-protection shall be reinforced with metal mesh reinforcement. Concrete protection for vertical columns of structural metal shall have reinforcing consisting of number five wire spaced not over eight inches apart or its equivalent. Reinforcement shall be wrapped around the structural member and so arranged as to be completely embedded in the fire-protective material and to ensure its integrity.

(c) Plaster used as fire-protection or to resist the spread of fire shall be reinforced with metal lath, except plaster less than one inch thick on masonry or concrete.

(d) In the protection of structural metal including reinforcement, one half inch of cement or gypsum plaster may replace an equal thickness of poured concrete or pneumatically projected mortar as protective material; and one inch of cement or gypsum plaster reinforced with metal lath may replace an equal thickness of poured concrete, pneumatically projected mortar or masonry protection.

(e) Where plaster is required without other specification, it shall consist of one half inch of cement or gypsum plaster, except that only gypsum plaster shall be used on gypsum masonry.

(f) In this chapter, except where otherwise specifically stated, the thickness given in a list of materials applies to the next following item only, and not to the total thickness where additional materials are specified.

(g) Pipes, wires, conduits and ducts shall not be embedded in or placed behind the fire-protective materials required for the protection of structural steel or iron except as otherwise provided in this paragraph. Above fire-protective hung ceilings and within the enclosed spaces in buildings of Type I and Type II construction, within which, other than the enclosure, fire protection of steel is not required, as specified in Part 16, pipes, wires, conduits and ducts may be placed, provided they are so arranged and so secured that they will not, either by expanding in the event of fire, or otherwise impair the effectiveness of the enclosing protective materials. Electric conduits and wires and gas pipes may be embedded in concrete or masonry fire protection of structural steel where the protective material is reinforced with wire mesh, provided they shall have protective covering except over the tops of beams and girders, at least as thick as required for the steel.

(h) In factories, garages, warehouses and other buildings in which the fire-protective covering required for steel or iron columns may be injured by the movement of vehicles, materials or equipment, the commissioner shall require such covering to be protected by metal or other material in a manner satisfactory to him.

(i) Fire-stopping, for the purposes of this chapter, shall mean the stopping-off or enclosure at the ends and wherever else specified of the spaces between studs of partitions, joists of floors and roofs and other similar spaces to prevent drafts of air and the communication of fire from one such space to another. Fire-stopping shall consist of wood not less than one and one half inches thick, of sheet metal not less than twenty-four gage or of masonry, or a combination of such materials. Fire-stopping shall be tightly fitted in the space to be filled, about pipes, wires and ducts and if cut or disturbed in the placement of pipes, wires and ducts shall be repaired.

[†*As amended by Ord. 1943, ch. 6*]

‡**Sect. 2203. Fire-Protection of Steel Columns.**— (a) Structural steel columns required to have fire-protection of a given rating shall be covered on all sides with protective material having not less than the thickness necessary for the required rating. Except where "no fill" is specified, re-entrant and other accessible spaces behind the specified outer protection shall be filled with concrete or brick masonry or the material of the outer protection.

(b) The following materials shall be assumed to afford to steel columns fire-protection of the rating indicated:

Four-hour rating:

(1) Two inches Class 1 concrete.
(2) Three inches Class 2 concrete, metal mesh reinforcement.
(3) Three and one half inches brick masonry.

(4) Two layers two-inch structural clay partition tile masonry, metal mesh in beds.

(5) Two inches structural clay partition tile masonry, concrete fill, metal mesh in beds, three fourths inch gypsum plaster.

(6) Four inches structural clay partition tile masonry, concrete fill, metal mesh in beds, five eighths inch lime plaster.

(7) Four inches structural clay partition tile or concrete block masonry, concrete fill, plaster.

(8) Three inches hollow gypsum tile masonry and plaster.

(9) Two inches gypsum concrete, metal mesh reinforcement.

(10) Two inches solid gypsum tile masonry and plaster.

(11) Three inches solid cinder concrete block masonry and plaster.

(12) Four inches hollow cinder concrete block masonry and plaster.

Three-hour rating:

(13) One and three fourths inches Class 1 concrete.

(14) Two inches Class 2 concrete, metal mesh reinforcement.

(15) Two inches gypsum concrete.

(16) Two inches solid cinder concrete block masonry and plaster.

(17) Two inches structural clay partition tile masonry, concrete fill.

Two-hour rating:

(18) One and one half inches Class 1 concrete.

(19) Two inches Class 2 concrete, metal mesh reinforcement.

(20) One inch Class 1 or Class 2 concrete encased in standard weight steel or wrought iron pipe.

(21) Two inches structural clay partition tile masonry and plaster.

(22) Two layers plaster, each on metal lath, with three fourths inch air space between, two inches total thickness.

(23) Two inch gypsum concrete.

(24) Two inches solid or three inches hollow gypsum tile masonry.

One-hour rating:

(25) One inch Class 1 concrete.

(26) One and one half inches Class 2 concrete with metal mesh reinforcement.

(27) Two and one fourth inches brick masonry.

(28) Two inches structural clay partition tile or concrete block masonry.

(29) One inch cement or gypsum plaster on metal lath.

(c) The thickness of protection on the outer edges of lugs or brackets need not exceed one inch.

[‡*As amended by Ord. 1943, ch. 6*]

*Sect. 2204. **Fire-Protection of Cast Iron Columns.**— (a) Cast iron columns required to have fire-protection of a given rating shall be covered on all sides with protective materials having not less than the thickness necessary for the required rating. Re-entrant spaces, if any, on the exterior of cast iron columns, and other accessible spaces behind the specified protection, shall be filled with Class 1 concrete or brick masonry or the material of the outer protection.

(b) The following materials shall be assumed to afford to cast iron columns fire-protection of the rating indicated:—

Four-hour rating:—

Cast iron columns shall not be used where protection of four-hour rating is required.

Three-hour rating:—

(1) Two inches Class 1 concrete.

(2) Three inches Class 2 concrete, metal mesh reinforcement.

(3) Two inches structural clay partition tile or concrete block masonry concrete fill.

(4) One and one half inches cement or gypsum plaster on metal lath and metal furring to form one half inch air space.

Two-hour rating:—

(5) One and one half inches Class 1 concrete.

(6) Two inches Class 2 concrete with metal mesh reinforcement.

One-hour rating:—

(7) One inch Class 1 concrete.

(8) One and one half inches Class 2 concrete with metal mesh reinforcement.

(9) One inch cement or gypsum plaster on metal lath.

[**As amended by Ord. 1943, ch. 6*]

†**Sect. 2205. Fire-Protection of Steel in Reinforced Concrete Columns.**—(a) The main steel reinforcement, including spiral reinforcement and ties larger than one half inch, in reinforced concrete columns required to have fire-protection of a given rating shall be covered with concrete having not less than the thickness listed in this section for the rating indicated:—

Four-hour rating:—

(1) One and one half inches Class 1 concrete.

(2) Two inches Class 2 concrete.

Three-hour rating:—

(3) One and one half inches Class 1 or Class 2 concrete.

Two-hour rating:—

(4) One inch Class 1 concrete.

(5) One and one half inches Class 2 concrete.

One-hour rating:—

(6) One inch Class 1 or Class 2 concrete.

(b) The thickness of protection on column ties not larger than one half inch may be one half inch thinner than that listed above.

[*†As amended by Ord. 1943, ch. 6*]

‡**Sect. 2206. Fire-Protection of Steel Beams, Girders and Trusses.**—(a) Steel beams, girders and trusses or the members of trusses, required to have fire-protection of a given rating, shall be covered on all sides with material having not less than the thickness necessary for the required rating.

(b) The following materials shall be assumed to afford steel beams, girders and trusses, or the members thereof, fire-protection of the rating indicated:

Four-hour rating:

(1) Two inches Class 1 concrete.

(2) Three inches Class 2 concrete.

(3) Three inches structural clay partition tile or concrete block masonry and plaster.

(4) Three inches hollow gypsum tile masonry and plaster.

(5) Two inches gypsum concrete.

(6) Two inches solid gypsum tile masonry and plaster.

Three-hour rating:

(7) One and three quarters inches Class 1 concrete.

(8) Two and one half inches Class 2 concrete.

(9) Two inches gypsum concrete.

(10) Two inches structural clay partition tile, or concrete block masonry and plaster.

(11) Two inches solid, or three inches hollow gypsum tile masonry.

Two-hour rating:

(12) One and one half inches Class 1 concrete.

(13) Two inches Class 2 concrete.

(14) Two inches gypsum concrete.

One-hour rating:

(15) One inch Class 1 concrete.

(16) One and one half inches Class 2 concrete.

(17) Seven eighths inch cement or gypsum plaster on metal lath.

[‡*As amended by Ord. 1943, ch. 6*]

***Sect. 2207. Fire-Protection of Steel in Reinforced Concrete Beams.**—(a) The main steel reinforcement, including stirrups larger than one half inch, in reinforced concrete beams, girders and trusses, including the ribs of reinforced concrete ribbed floors or roofs where one or both sides of the ribs, in addition to the soffit, are exposed to fire, required to have fire-protection of a given rating, shall be covered on all sides with concrete having not less than the thickness listed in this section for the required rating. Where a reinforced concrete floor or roof has a flush ceiling formed with approved permanent masonry fillers between ribs, the reinforcement shall have the protection required for reinforcing steel of floors and roofs in section twenty-two hundred and eight.

Four-hour rating:—

(1) One and one half inches Class 1 concrete.

(2) Two inches Class 2 concrete.

Three-hour rating:—

(3) One and one half inches Class 1 or Class 2 concrete.

Two-hour rating:—

(4) One inch Class 1 concrete.

(5) One and one half inches Class 2 concrete.

One-hour rating:—

(6) One inch Class 1 or Class 2 concrete.

(b) The thickness of protection on stirrups not larger than one half inch may be less than that listed by not more than one half inch.

[**As amended by Ord. 1943, ch. 6*]

†Sect. 2208. Fire-Protection of Steel Reinforcing in Floors and Roofs.—(a) The steel reinforcement in reinforced concrete floors and roofs with flush or plane ceilings, such that the exposure to fire is on the soffit only, required to have fire-protection of a given rating, shall be covered with concrete having not less than the thickness listed in this section for the required rating. In floors or roofs having reinforced concrete ribs where the concrete surrounding the steel reinforcement is exposed to fire on one or both sides in addition to the soffit, such reinforcement shall have the protection specified in section twenty-two hundred and seven for steel in reinforced concrete beams.

Four-hour rating:—

(1) One inch Class 1 concrete.

(2) One and one fourth inches Class 2 concrete.

Three-hour rating:

(3) One inch Class 1 or Class 2 concrete.

Two-hour rating:—

(4) Three fourths inch Class 1 concrete.

(5) One inch Class 2 concrete.

One-hour rating:—

(6) Three fourths inch Class 1 or Class 2 concrete.

[*†As amended by Ord. 1943, ch. 6*]

‡Sect. 2209. Fire-Resistive Floor and Roof Construction. — (a) Floors and roofs required to have resistance of a given rating to the spread of fire shall have such thickness of the materials of which it is constructed, as shall be necessary for the required rating, and structural metal forming a part of such floors or roofs shall have protection against fire of such required rating. Floors and roofs required to have two-hour or longer resistance to fire shall be constructed of incombustible materials. Granolithic, burned clay tile, ceramic tile or other similar incombustible floor finish of a given thickness may be substituted for an equal thickness, and sand, cinder or other incombustible filling material, with or without embedded wooden screeds, may be substituted for two thirds its thickness, of the floor or roof construction material specified in this section; provided, that such floors and roofs shall have adequate thickness for structural purposes.

(b) The following floor or roof construction shall be assumed to afford resistance to the spread of fire of the rating indicated:

Four-hour rating:

(1) Four inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

(2) Four inches solid masonry arches or slabs.

(3) Four inches structural clay floor tile masonry arches or slabs with top covering of not less than two inches of solid masonry or reinforced concrete.

(4) Five inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one and one half inches of concrete topping; but if structural clay partition tiles are used for fillers they shall be plastered on the soffit.

Three-hour rating:

(5) Three inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

(6) Three inches solid masonry arches or slabs.

(7) Four inches structural clay floor tile masonry, arches or slabs with top covering of not less than one and one half inches of solid masonry or reinforced concrete.

(8) Four inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one-inch concrete topping; but if structural clay partition tiles are used for fillers, they shall be plastered on the soffit.

Two-hour rating:

(9) Two and one half inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

(10) Two and one half inches solid masonry arches or slabs.

(11) Three inches structural clay floor tile masonry, arches or slabs with top covering of not less than one inch of solid masonry or reinforced concrete.

One-hour rating:

(12) Three inches structural clay floor tile masonry, arches or slabs with all joints thoroughly filled with cement or gypsum mortar.

(13) Wood floor or roof construction with joists not less than one and five-eighths inches in least dimension, fire-stopped, double board floor, approved asbestos felt between layers of boards, and with a ceiling of at least three quarters inch cement or gypsum plaster on metal lath.

(14) Steel beams or steel joists not more than thirty-six inches apart on centers with incombustible floor and a ceiling of at least three fourths inch cement or gypsum plaster on metal lath metal furring.

[‡*As amended by Ord. 1943. ch. 6*]

***Sect. 2210. Fire-Resistive Ceiling Construction.** — (a) Ceilings required to afford fire-protection of a given rating to the floor or roof framing under which it is supported shall be of fire-resistive materials of at least the thickness necessary for the given rating. A fire-resistive ceiling and all hangers and fastenings necessary for its support to the protected framing shall be of incombustible materials. It shall be capable of sustaining its own weight without exceeding allowable stresses. Metal reinforcement in such a ceiling shall be protected from fire as specified in section twenty-two hundred and eight for reinforcing in a floor.

(b) The following ceiling construction shall be assumed to afford to floor or roof framing fire-protection of the rating indicated:—

Four-hour rating:—

(1) Two and one half inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

(2) Two inches precast reinforced gypsum concrete, plastered.

Three-hour rating:—

(3) Two inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

(4) Two inches precast reinforced gypsum concrete, lapped or rabbeted joints.

Two-hour rating:—

(5) One and one half inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

One-hour rating:—

(6) Three fourths inch cement or gypsum plaster on metal lath.

[**As amended by Ord. 1943, ch. 6*]

†**Sect. 2211. Fire-Resistive Bearing Walls and Partitions.**—(a) Bearing walls and partitions required to have resistance to fire or the spread of fire of a given rating shall be constructed of fire-resistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two-hour or longer rating shall be of incombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in section twenty-two hundred and eight for steel in floors.

(b) Bearing walls and partitions of the following construction and thickness shall be assumed to have resistance to fire and the spread of fire of the rating indicated:

Four-hour rating:

(1) Eight inches solid brick masonry.

(2) Twelve inches hollow wall of brick masonry, minimum eight inch masonry thickness.

(3) Twelve inches structural clay load-bearing tile masonry with two units and not less than three cells in the thickness of the wall.

(4) Eight inches structural clay load-bearing tile masonry with one unit and not less than two cells in the thickness of the wall, plastered both sides.

(5) Twelve inches concrete block masonry with one unit and not less than two cells in the thickness of the wall.

(6) Eight inches one-piece concrete block masonry with shells and webs at least one and one half inches thick, plastered both sides.

(7) Twelve inches total thickness of brick masonry facing bonded to structural clay load-bearing tile masonry backing.

(8) Eight inches solid concrete.

(9) Six inches solid reinforced concrete.

(10) A steel or reinforced concrete frame bearing wall in which the steel has fire-protection of four-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of four-hour rating.

Three-hour rating:

(11) Eight inches structural clay load-bearing tile masonry with two units and not less than four cells in the thickness of the wall.

(12) Twelve inches structural clay load-bearing tile masonry with one unit and not less than three cells in the thickness of the wall.

(13) Eight inches one-piece concrete block masonry with shells and webs not less than one and one half inches thick, plastered both sides.

(14) Eight inches one-piece concrete block masonry with shells and webs not less than two inches thick.

(15) Five inches solid reinforced concrete.

(16) A steel or reinforced concrete frame bearing wall in which the steel has fire-protection of three-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of three-hour rating.

Two-hour rating:

(17) Eight inches structural clay load-bearing tile masonry with not less than three cells in the thickness of the wall.

(18) Eight inches concrete block masonry with shells and webs not less than one and one half inches thick.

(19) A steel or reinforced concrete frame bearing wall in which the steel has fire-protection of two-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of two-hour rating.

One-hour rating:

(20) A steel or wooden stud bearing wall covered on both sides with one-inch cement or gypsum plaster on metal lath, fire-stopped, if of wood.

(21) A steel or reinforced concrete frame bearing wall in which the steel has fire-protection of one-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of one-hour rating.

[†*As amended by Ord. 1943, ch. 6*]

‡**Sect. 2212. Fire-Resistive Non-Bearing Walls and Partitions.**— (a) Non-bearing walls and partitions required to have resistance to fire and the spread of fire of a given rating shall be constructed of fire-resistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two-hour or longer rating shall be of incombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in section twenty-two hundred and eight for steel in floors.

(b) Non-bearing walls and partitions of the following construction and thickness shall be assumed to have resistance to fire and the spread of fire of the rating indicated:

Four-hour rating:

(1) Eight inches solid brick masonry.

(2) Three and one half inches solid brick masonry, plastered both sides.

(3) Six inches structural clay load-bearing tile, plastered both sides.

(4) Six inches solid concrete.

(5) Four inches solid reinforced concrete.

(6) Any wall which, as a bearing wall, has a three-hour or four-hour rating in section twenty-two hundred and eleven, except the steel or reinforced concrete frame bearing wall.

Three-hour rating:

(7) Three and one half inches solid brick masonry.

(8) Four inches structural clay load-bearing tile, plastered both sides.

(9) Four inches solid concrete.

(10) Three inches reinforced concrete.

(11) Any wall which, as a bearing wall, has a two-hour rating in section twenty-two hundred and eleven, except the steel or reinforced concrete frame bearing wall.

Two-hour rating:

(12) Three inches gypsum tile masonry, plastered both sides except in exterior walls.

(13) Eight inches structural clay partition tile masonry, plastered both sides.

(14) Eight inches structural clay load-bearing tile, with three cells in the thickness of the wall.

(15) Four inches concrete block plastered both sides.

(16) Two inches solid neat, fibered, gypsum plaster on metal lath and incombustible studding.

One-hour rating:

(17) Three inches gypsum tile masonry.

(18) Two inches solid gypsum tile masonry plastered both sides.

(19) Three inches structural clay partition tile plastered both sides.

(20) Two and one half inches solid cement or sanded gypsum plaster on metal lath and incombustible studding.

(21) Three inches total thickness of hollow wall, three fourths inch cement or gypsum plaster on metal lath and incombustible studding.

(22) Three inches total thickness of hollow wall, three fourths inch cement or gypsum plaster on metal lath and wooden studding, fire-stopped.

[‡*As amended by Ord. 1943, ch. 6*]

*Sect. 2213. **Fire-Resistive Doors.**—(a) Doors which are required to be fire doors, fire-resistive doors, or of fire-resistive construction shall conform to the requirements of this section and section twenty-two hundred and fourteen.

(b) Fire doors shall be classified for the purposes of this code as Class A, Class B, and Class C.

(c) Class A fire doors shall be doors of the following construction as specified in Section twenty-two hundred and fourteen.

(1) Tin-clad, three-ply wood core, sliding.

(2) Tin-clad, three-ply wood core, swinging single leaf, doorway not over six feet wide.

(3) Tin-clad, three-ply wood core, swinging in pairs, doorway not over ten feet wide.

(4) Hollow metal, swinging single leaf, doorway not over four feet wide.

(5) Hollow metal, swinging in pairs, doorway not over eight feet wide.

(6) Sheet metal, sliding, single, doorway not over ten feet wide.

(7) Sheet metal, sliding in pairs, doorway not over twelve feet wide.

(8) Sheet metal, swinging single leaf, doorway not over six feet wide.

(9) Sheet metal, swinging in pairs, doorway not over ten feet wide.

(10) Steel rolling, doorway not over twelve feet wide.

(11) Steel plate, doorway not over four feet wide.

(12) Any other construction equal or superior to a tin-clad three-ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

(d) Class B fire doors shall be doors of the following construction as specified in section twenty-two hundred and fourteen.

(13) Tin-clad, three-ply wood core.

(14) Tin-clad, two-ply wood core, sliding, doorway not over ten feet wide.

(15) Tin-clad, two-ply wood core, swinging single leaf, doorway not over six feet wide.

(16) Tin-clad, two-ply wood core, swinging in pairs, doorway not over ten feet wide.

(17) Hollow metal, sliding, doorway not over eight feet wide.

(18) Metal-clad, paneled, swinging single leaf, doorway not over three feet wide.

(19) Metal-clad, paneled, swinging in pairs, doorway not over six feet wide.

(20) Any other construction equal or superior to a tin-clad two-ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

(e) Class C fire doors shall be doors of the following construction as specified in section twenty-two hundred and fourteen.

(21) Metal-clad, paneled, swinging single leaf, doorway not over four feet wide.

(22) Metal-clad, paneled, swinging in pairs, doorway not over eight feet wide.

(f) A Class A door may be used where Class B or Class C is specified; a Class B door may be used where Class C is specified. Two Class B or Class C doors on opposite sides of the wall may be used where a single Class A or Class B door is specified.

(g) Fire-resistive doors, when closed, shall completely cover the doorways in the walls and partitions or the openings in the floors or roofs to which they are fitted. A swinging fire door shall either overlap both jambs and the head of the opening not less than four inches or be fitted to a fire-resistive frame with a rabbet the full thickness of the door and with not less than one half inch overlap on the door. A sliding fire door, except in enclosures about passenger elevators, shall overlap both jambs and the head of the opening not less than four inches. A sliding fire door in an enclosure about a passenger elevator shall overlap jambs, head and adjoining panels not less than one

half inch. Fire doors shall fit closely at the floor with clearance of not over one quarter inch.

(h) In buildings with combustible floors, doorways required to have fire doors shall have incombustible thresholds the full thickness of the wall, extending at least four inches from the face of the wall where a door is hung and extending laterally at least six inches beyond each jamb of the doorway. Thresholds may be flush with the floor.

(i) The rabbeted frame of a swinging fire door shall be constructed of structural steel built into the concrete, masonry or other fire-resistive material of the wall about the opening and secured thereto, except that the rabbeted frame of a Class B or Class C door may be of wood, covered with sheet metal not less than twenty-six gage in thickness, secured to the wall in the opening.

(j) Fire doors when closed shall fit tightly against the wall or frame so as to provide an effective stop for fire and smoke. Except for the metal-covered wooden frame specified in this section, combustible material shall not intervene between the door and the fire-resistive material of the wall, floor or roof to which it is fitted.

(k) Hinge hardware for fire doors shall be of malleable iron or rolled structural steel not less than one fourth inch thick except that tubular steel track for sliding doors may be not less than one eighth inch thick. Equivalent thickness of solid bronze or brass may be used. Fire doors shall not depend upon cords, cables or chains to support them in closed position except in elevator shafts.

(l) Tracks for sliding fire doors shall be so supported that a track hanger comes at each door hanger when the door is closed. Track hangers shall be secured to wood stud walls by screws or bolts, to steel stud walls by bolts or rivets, to masonry walls by through bolts and to concrete walls by through bolts or approved built-in inserts. Expansion shields shall not be used to support fire doors.

(m) Hinges for swinging fire doors, except in wooden stud walls, shall be riveted or through-bolted to the structural steel frame of the opening, through-bolted to the wall if of masonry or concrete or secured by approved inserts in the concrete or built into masonry in approved manner.

(n) Strap hinges and sliding door hangers shall be secured to fire doors by through-bolting, riveting or welding. Swinging fire doors in rabbeted frames, except tin-clad, wood core doors, may be hung on butts. Other swinging fire doors shall have strap hinges.

(o) Sliding fire doors shall have adequate stops for the closed position. Swinging Class A fire doors shall have surface latches or unit locks. Class B and Class C doors shall have surface latches, unit or mortise locks. The latch bolts of unit or mortise locks on fire doors shall have a throw of three fourths inch. When mounted in pairs fire doors shall be rabbeted by means of an astragal or otherwise where they come together. One of a pair of swinging fire doors shall have push bolts at top and bottom with a throw of three fourths inch and the other shall be held by latch to the first.

(p) Except in detention buildings, fire doors hung in required exits shall be so fitted with hardware that they can be opened from inside without use of a key when the building is occupied.

[**As amended by Ord. 1943, ch. 6*]

*Sect. 2214. **Fire Door Construction.** — (a) In the construction of fire doors solder shall not be used, except for filling joints. Sheet metal shall be fastened to wood by nailing and to metal frame by bolting, riveting or welding.

(b) Class A doors shall not have glass panels. Class B doors may have glass panels not larger than one hundred square inches in exposed area nor more than twelve inches in width or height. Class C doors may have glass panels not larger than two thousand and sixteen square inches in total exposed area, and no single light shall have an exposed area exceeding twelve hundred and ninety-six square inches. Glass in fire doors shall be wire glass not less than one quarter inch thick and shall be set five eighths inch in grooves three quarters of an inch deep.

(c) Fire doors shall be constructed as follows: —

(1) Tin-clad, three-ply wood core doors shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such doors in Class A openings, and shall bear the label of the Underwriters Laboratories to this effect.

(2) Tin-clad, two-ply wood core doors shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such doors in Class B openings and shall bear the label of the Underwriters Laboratories to this effect.

(3) Hollow metal doors shall have substantial stiles and rails of heavy pressed steel, reinforced for hinges and other hardware. Panels shall be of sheet steel filled with asbestos board or other approved insulating materials. The door shall be assembled by welding or riveting.

(4) Sheet metal doors shall be constructed with a rolled steel rigid frame covered both sides with one sixteenth inch asbestos board and twenty-six gage corrugated sheet metal, with corrugations vertical on one side and horizontal on the other, bound on the edges with rolled steel or pressed steel shapes.

(5) A steel rolling fire door shall be constructed of sheet steel interlocking slats, sliding in grooves, counterweighted by springs, the roller and mechanism enclosed in heavy sheet metal.

(6) A steel plate fire door shall be constructed of not less than twelve gage steel plate mounted on a rolled steel frame, assembled by welding or riveting.

(7) A metal clad, paneled fire door shall have a wood core with stiles and rails not less than one and three fourths inches thick covered with twenty-six gage sheet steel; panels three fourths inch thick covered with twenty-six gage sheet steel, set three fourths inch in grooves; joints of metal lapped and well nailed.

(d) A door properly bearing the Underwriters' Label certifying that it is suitable for the protection of a Class A opening shall be acceptable as a Class A door.

(e) A door properly bearing the Underwriters' Label certifying that it is suitable for the protection of a Class B opening shall be acceptable as a Class B door, except that metal clad doors wider than three feet shall not be accepted as Class B doors.

(f) A door properly bearing the Underwriters' Label certifying that it is suitable for the protection of a Class C opening shall be acceptable as a Class C door.

[**As amended by Ord. 1943, ch. 6*]

Sect. 2215. Fire-Resistive Shutters.— Shutters required to be fire shutters or fire-resistive shutters shall be constructed and hung as specified for Class B fire-resistive doors in sections twenty-two hundred and thirteen and twenty-two hundred and fourteen.

†Sect. 2216. Fire-Resistive Windows.— (a) Windows which are required to be fire windows, fire-resistive windows, or of fire-resistive construction shall conform to the requirements of this section.

(b) Fire-resistive windows may be fixed or arranged to open and close. Fixed fire-resistive windows shall be so secured in the walls in which they are placed that they may expand in case of fire without buckling. Movable fire-resistive windows shall be opened or closed in one of the following manners: —

(1) One or more sashes may slide horizontally in a fire-resistive frame.

(2) One or more sashes may slide vertically with counterweights or with two sashes counterbalanced and hung on chains. If a sash is closed in raised position it shall have a fastening.

(3) A sash may be hinged at top, bottom, or either side.

(4) A sash may be pivoted at top and bottom or at the sides.

(5) A sash may be arranged to open and close in any other approved manner, with approved hardware.

(c) Movable sashes in fire-resistive windows shall be fitted to fire-resistive frames of the same or similar construction. Both sashes and frames, and metal mullions between window units, shall be so fitted in the walls in which they are placed as to be continuous with the fire-resistive material of the wall and so secured that they may expand in case of fire without buckling.

(d) Glass in fire-resistive windows shall be wire glass not less than one fourth inch thick and the area of a single light shall not exceed seven hundred and twenty square inches. Glass shall be set three eighths inch in grooves at least one half inch deep. Glass shall be secured by glazing angles or moldings screwed to the sash and forming continuous grooves for the glass.

(e) Fire-resistive windows shall be of the following construction:—

(6) Hollow sheet metal sashes and frames fabricated by pressing, welding, riveting or crimping without the use of solder or other fusible alloy, except for filling joints, and bearing the label of the Underwriters' Laboratories.

(7) Rolled steel or pressed steel sashes fabricated by pressing, welding, riveting or crimping, of a make and style approved by the commissioner.

(8) Any other approved constructions as fire-resistive as that specified in paragraph (6).

(f) Fixed fire-resistive windows of hollow sheet metal construction shall not exceed seven feet in width nor ten feet in height. Fire-resistive windows of hollow sheet metal construction with movable sashes shall not exceed six feet in width nor ten feet in height.

(g) Fire-resistive windows of rolled steel construction shall not exceed eighty-four square feet in area nor twelve feet in either height or width.

(h) Fire-resistive windows and their fastenings shall be capable of resisting the wind pressure on the wall of the building applied either on the inside or the outside of the window without exceeding allowable stresses.

(i) Where fire-resistive windows are required, wooden windows and plain glass may be substituted provided the openings are protected by fire-resistive doors or shutters, or, in buildings of approved occupancy and construction, by an approved system of open sprinklers.

[†*As amended by Ord. 1943, ch. 6*]

‡**Sect. 2217. Fire-Resistive Roof Covering.**— (a) Roof covering allowed under this code shall be classified as fire-retardant or ordinary, according to their resistance to fire outside, as provided in this section. Fire-retardant roof covering is the more fire-resistive and may be used on any building. Ordinary roof covering shall not be used where fire-retardant roofing is specified. Roof covering less fire-resistive than ordinary roof covering shall not be used on any building.

(b) Fire-retardant roofing shall be any roof covering which meets the requirements of Class A or Class B roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for fire-retardant roofing:—

(1) Built up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asphalt in which, while molten, is embedded a continuous layer of roofing gravel or slag.

(2) Built up roofing consisting of successive layers of roofing felt impregnated with coal tar; a final layer of tar in which, while molten, is embedded a continuous layer of roofing gravel or slag.

(3) Built up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asbestos roofing felt impregnated with asphalt weighing not less than fourteen pounds per hundred square feet, or a final layer of asphalt-saturated prepared roofing coated with granulated slate or other similar material.

(4) Built up roofing consisting of successive layers of roofing felt impregnated with tar or asphalt and a finish of burned clay floor tile, stone flagging, cement concrete or other similar material.

(5) Sheet metal with locked and soldered joints not less than number twenty-six gage in thickness.

(6) Shingles of natural slate.

(7) Shingles of burned clay tile.

(8) Shingles of sheet metal not less than number twenty-six gage in thickness.

(9) Shingles of asbestos board not less than one eighth inch thick.

(10) Shingles of asphalt saturated felt surfaced with granulated slate or other similar material and carrying the Underwriters Class "C" label.

(11) Corrugated sheet metal with lapped joints not less than number twenty-six gage in thickness.

(12) Corrugated asbestos board not less than three sixteenths inch thick.

(c) Ordinary roofing shall be any roof covering which meets the requirements of class C roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for ordinary roofing:—

(13) Built up roofing consisting of successive layers of roofing felt impregnated with asphalt, coal tar or other approved material, not equal in fire-resistance to a fire-retardant roofing.

(14) Prepared roofing consisting of felt or fabric impregnated or coated, or both, with asphalt, tar or other approved material or shingles of such prepared roofing, not equal in fire-resistance to fire-retardant roofing.

(15) Canvas stretched tightly and coated with paint.

(d) Built-up roofing shall be secured to the roof deck in the following manner:

1 Over masonry slab. The first layer shall be laid in molten asphalt or tar mopped on the roof deck, after the deck is properly primed, or by nailing a layer of building paper to nailing inserts other than wood placed in the deck.

2 Over wood decks the built-up roofing shall be secured by nailing a layer of building paper to the roof deck over which the prepared roofing is to be laid with the first layer laid in molten asphalt or tar.

3 Roofings other than built-up roofings, such as shingles, slates, tile roll roofing shall be well secured to the deck by nailing, bolting, wiring, or other approved methods.

[‡*As amended by Ord. 1943, ch. 6 and 9*]

PART 23.

DEAD AND LIVE LOADS.

Section 2301. Design for Loads.—All buildings and other structures and parts thereof shall be designed to support the loads and to withstand the forces to which they are to be subjected during construction as well as after completion. The design shall allow for dead and live loads including wind and snow loads as required in this part without exceeding the allowable stresses prescribed for supporting members elsewhere in this code.

Sect. 2302. Dead and Live Loads.—(a) The dead loads acting upon a building or structure shall include all the forces due to weight of walls, permanent partitions, floors, roofs, framing and all other permanent stationary construction and fixed service equipment entering into and becoming part of the structure.

(b) The live loads acting upon a building or structure shall include all loads other than dead loads.

Sect. 2303. Weights of Materials.—(a) The actual weights of the constituent parts of a structure and of materials to be supported shall be used in calculation of loads. The materials listed in the following table shall be taken to weigh not less than there indicated:

	Pounds Per Cubic Foot
Masonry:	
Brick (face, clay, shale, or concrete)	140
Brick (sand-lime)	113
Brick (common)	120
Cast stone	144
Clay tile	60
Concrete (Portland cement, sand and stone aggregates):	
Unreinforced	144
Reinforced	150

	Pounds Per Cubic Foot
Concrete (Portland cement, sand cinder aggregates):	
Fill	100
Glass block	54
Granite	165
Limestone	160
Marble	160
Sandstone	144
Metals:	
Cast iron	450
Steel	490
Soils:	
Earth, common, dry and compacted	100
Sand and gravel, compacted	120
Timber, structural	40
Plaster:	
Gypsum, on tile or concrete	5
Gypsum, and wood lath (excluding furring)	8
Gypsum, and suspended metal lath	10
Cement, and suspended metal lath	15
Roofing, tar and gravel	6
Water (fresh)	62.4

Sect. 2304. Loads from Partitions.—(a) In structures in which permanent partitions occur their weight shall be counted as affecting the design of all supporting structural members, including columns and foundations, as part of the dead load; and in those portions of office buildings in which the prescribed live load does not exceed fifty pounds per square foot, allowance for partition weight shall always be made whether or not partitions are shown on plans.

(b) If a layout of partitions is included in the building plans, the weights of the partitions and their locations shall be determined in accordance therewith, or such layout shall be used to determine an equivalent load per square foot of floor to be applied uniformly as a super-imposed dead load for purposes of design. But the allowance for partition weight in portions of buildings given to office occupancy, when expressed in pounds per square foot of floor, shall in no case be less than a minimum of two pounds for each foot of story height for each square foot of floor.

(c) In estimating loading from actual weights of partitions it may be assumed that the partition occupies a space one foot wide, and a deduction may be made of the live load displaced on this width.

(d) Arch action of partitions shall not be assumed to relieve the supporting members.

Sect. 2305. Live Loads on Floors.—The live loads taken on floors for purposes of design shall be the greatest loads that will probably be produced by the intended occupancies but the following distributed live loads shall be taken as the minimum for the occupancies named. For occupancies not listed, the design engineer shall submit the proposed design live load to the Commissioner for approval. All plans filed for permit shall include a list or notation of the live loads used in design. In buildings, structures or portion thereof used for industrial, mercantile or storage occupancies the live load for which each floor or part of a floor is designed and approved shall be conspicuously posted in that part of the story to which it applies. See also Section 114.

	Pounds per Square Foot
Domestic Occupancy: All parts of private dwellings, rooms and suites in apartment houses, lodging houses and clubs, private, ward or dormitory rooms in hospitals, asylums, educational and religious institutions, including corridors giving access thereto, and bedrooms of hotels	40
Office Buildings:	
Basement	100
First Floor	80
Upper Floors	50*
Church Auditoriums: With fixed seats, including aisles, sanctuary or chancel, sacristies, choirs and chapels	60
Classrooms: Not exceeding nine hundred square feet in area, or larger size rooms where fixed seats are used	50
Kitchen: Other than domestic, and school laboratories	100
Theatre Auditorium and Assembly Halls: With fixed seats, including aisles and passageways	75†
Theatre Stages: Gridirons and fly galleries	150
Public Occupancy: Lobbies, foyers, vestibules and similar public spaces of hotels, theatres, churches, clubs, and public buildings; assembly halls, including class and lecture rooms exceeding nine hundred square feet in area, without fixed seats; dance halls, public dining rooms and restaurants, public rooms for social purposes, skating rinks, gymnasiums	100
Bleachers: Grandstands and temporary grandstands	150
Corridors:	
In theatres and those serving assembly halls	100
In school buildings	75
Other corridors same loading as heaviest occupancy to which they provide access	

*See Section 2304

	Pounds per Square Foot.
Fire Escapes and Exterior Balconies:	
Serving theatres or assembly halls	100
In other buildings	75
Stairs:	
Same loading as heaviest occupancy to which they give access, but maximum required	100†
Stores:	
For light merchandise, first and basement floors	100
For light merchandise, above first floor, including mezzanine	75
For heavy merchandise, all floors	125
Storage:	
Light storage	125
Heavy storage	250
Manufacturing:	
Light manufacturing	75
Intermediate manufacturing	150
Heavy manufacturing	250
Locker Rooms	75
Garages: Including Apparatus Rooms of Fire Stations:	
Class A—Floors used for vehicles exceeding 20,000 lbs. in weight, including loads; and first or street floors of garages except those limited exclusively to passenger vehicles of not more than 9 persons capacity	250†
Class B—Floors not included in Class A and first or street floors of garages limited to passenger vehicles exclusively weighing not more than 9,000 lbs	150†
Class C—Floors above the first or street floors for passenger vehicles weighing less than 6,000 lbs	100†
A floor connected directly with the street or by a ramp or driveway not more than eight feet high shall be regarded as a first or street floor	
Sidewalks	250†
Driveways	250†

Sect. 2306. Special Concentrations.—In the design of floors and structural systems, consideration shall be given to the effects of known or probable concentrations of load to which they may be subjected; and in structures designed for the occupancies listed herein, floors shall be made capable of carrying the prescribed distributed loads or the following minimum concentrations, whichever may result in the greater stresses. Unless otherwise noted the following concentrated loads indicated, in pounds shall be taken to occupy a space two and one-half feet square, and so placed as to produce maximum stresses in the members affected:

†For special floor concentrations and lateral thrusts on stair and balcony rails, see Sections 2306 and 2309.

	Pounds per Square Foot.
(1) For office floors including corridors, theatre stages, gridirons and fly galleries and corridors serving them	2,000 lbs.
(2) For portions of garages subject to:	
Class A loading	20,000 lbs.
Class B loading	10,000 lbs.
(3) For sidewalks	12,000 lbs.
(4) For driveways, and for trucking spaces within the limits of a structure	20,000 lbs.
(5) For structural supports of ceilings under accessible spaces, and for trap doors and skylights	200 lbs.
(6) That portion of hangars subject to concentrated loads shall be designed to accommodate the heaviest vehicle housed therein	
(7) For elevator machine room grating (on an area of four square inches)	300 lbs.
(8) For stair treads (on an area of four square inches)	300 lbs.
(9) For exposed metal light floor plate construction (on an area of one square inch)	200 lbs.

Sect. 2307. Partial Loadings.—(a) The effect of a partial live load on a structure—taking into account its construction connections and rigidity—which will produce maximum stress in any member shall be provided for in the design as well as the full live load.

(b) The partial loading shall also conform to the design requirements of other sections of this code.

(c) For snow and wind load requirements, see Sections 2311 and 2312.

Sect. 2308. Impact.—(a) The live loads prescribed herein include a sufficient allowance to cover the effects of ordinary impact.

(b) For structures carrying live loads which induce unusual vibration or impact forces, the live load shall be increased sufficiently to provide for same. For machinery and other vibratory loads care shall be taken to avoid near resonant conditions.

(c) The increase shall be:

For supports of elevators	100 Percent
For traveling crane support girders and their connections	25 Percent
For supports of light machinery, shaft or motor driven, not less than	20 Percent
For supports of reciprocating machinery or power driven units not less than	50 Percent
For hangers supporting floors and balconies	33 Percent

(d) The lateral force on crane runways to provide for the effect of moving crane trolleys shall, if not otherwise specified, be 20 percent of the sum of the weights of the lifted load and of the crane trolley (but exclusive of other parts of the crane), applied at the top of rail, one half on each side of the runway; and shall be considered as acting in either direction normal to the runway rail.

(e) The longitudinal force shall, if not otherwise specified, be taken as 10 percent of the maximum wheel loads of the crane applied at the top of rail.

Sect. 2309. Lateral and Uplift Forces.—(a) In the design of basement walls and similar approximately vertical structures below grade, the forces due to lateral pressure of adjacent soil shall be calculated. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or the whole of the adjacent soil is below a free water surface, calculations shall be based on the weight of the soil as diminished by buoyancy, plus full hydrostatic pressure.

(b) In the design of structures below ground grade, the upward pressure of water, if any, in the supporting soil, shall be taken as the full hydrostatic pressure applied over the entire area.

(c) Balcony and stairway railings, exterior and interior, shall be designed to resist a horizontal thrust of twenty pounds per linear foot applied at the top of the rail.

Sect. 2310. Reduction of Live Loads.—(a) Roof Live Loads—No reduction shall be made in the roof live load. No reduction shall be made in wind loads.

(b) Live Loads 100 Pounds per Square Foot or Less—For uniformly distributed live loads of 100 pounds or less per square foot the design live load on any member (except one-way slabs) supporting 150 square feet or more may be reduced at the rate of 0.06 percent per square foot of area supported by the member, except that no reduction shall be made for areas to be occupied as places of public assembly. The reduction shall exceed neither R as determined by the following formula, nor 50 per cent:

$$R = 100 \times \frac{D \text{ plus } L}{5L}$$

in which

R = reduction in percent
D = dead load per square foot of area supported by the member
L = design live load per square foot of area supported by the member

(c) Live Loads Exceeding 100 Pounds per Square Foot—For live loads exceeding 100 pounds per square foot, no reduction shall be made, except that the design live loads on columns may be reduced by ½ the percentage specified in (b).

Sect. 2311. Roof and Snow Loads.—(a) Flat roofs and roofs having a rise of two inches or less per foot of run shall be designed to support a vertical

snow load of thirty pounds per square foot of horizontal projection. Roofs used as roof gardens, or for other such purposes shall be designed as floors to support the load prescribed for corresponding occupancies.

(b) Roofs having a rise of more than two and less than twelve inches per foot of run shall be designed for a vertical snow load of (34-2r) pounds per square foot of horizontal projection in which r is the rise in inches per foot of run.

(c) Roofs having a rise of twelve inches or more per foot of run shall be designed for a vertical snow load of ten pounds per square foot of horizontal projection.

(d) Roof structures or portions thereof shall be designed for stresses produced by partial snow loading whenever such stresses exceed those produced by full snow loading. In such cases the partial snow load per square foot shall be taken as two thirds of the load required by paragraph a, b, or c of this section.

(e) All roofs shall be designed for the wind loads specified in Section 2312 in addition to the live loads presented in this section. Two thirds of the wind load required by Section 2312 shall be combined with two thirds of the snow load required by paragraph a, b, c, or d of this section, whenever such a combination produces higher stresses than those existing with wind or snow load acting separately.

Section 2312. Wind Loads.—(a) All structures shall be designed to resist wind forces applied to both walls and roofs without exceeding the stresses allowed elsewhere in this code.

(b) The design wind pressure P in pounds per square foot shall vary with the height above the average ground elevation adjacent to the base of the structure in accordance with the following table: For a sloping roof the heights of the structure shall be measured to the average height of the roof.

Height in Feet	P in Lbs. Per Sq. Foot
0 to less than 25	20
25 to less than 50	25
50 to less than 100	30
100 to less than 150	35
150 to less than 400	45
400 to less than 700	55
700 to less than 1,500	65

(c) Wind pressure on the elements of a structure shall not be less than the following values:

Total horizontal pressure on the walls of rectangular buildings (combining the effect of pressure on the windward wall and suction on the leeward wall)	1.0 P
Total horizontal pressure acting simultaneously on each of any two perpendicular walls of a rectangular building (combining the effect of pressure on the windward walls and suction on the leeward walls)	.7 P

Pressure in or out on an exterior wall	1.0 P
Total suction on the entire surface of all roofs	1.2 P
Pressure normal to windward surface only of roofs with slopes equal to or greater than 30 degrees (to be combined with zero pressure on leeward slope)	.9 P
Uplift on eaves, cornices or other local projections, and fastenings of roof coverings	1.5 P
Total pressure on gross area of signs with less than 25% openings	1.2 P
Total pressure on net area of signs with more than 25% openings	1.6 P
Total pressure on projected area of round chimneys or tanks	.7 P

(d) As an alternative to the provisions of Section 2312 (c) and with the approval of the Building Commissioner, wind force on a building may be based on shape coefficients obtained from wind tunnel tests of models or by other approved methods. Such shape coefficients shall include the full effect of openings in wall or roof surfaces. In such cases the velocity pressure "q" to be used at any height shall be taken as .77P where P is given by the table in paragraph 2312 (b).

(e) The overturning moment due to wind pressure shall not exceed 66 2/3 percent of the moment of stability due to the dead load only, unless the building or structure is securely anchored to the foundation to resist this force.

Section 2313. Load Tests of Structures.—(a) The Commissioner may order tests under load or other tests of any portion of a structure (whenever the Commissioner doubts the adequacy of a structure to serve the purpose for which it was intended). Such tests shall not be required to be made on any concrete or masonry construction until it is at least sixty days old.

(b) In such tests the member or portion of the structure under test shall be subject to a total load including its own weight which shall equal the total dead load plus twice the live load for which it is required to be designed. This load shall be left in position for a period of twenty-four hours before removal. The structure, if a floor or portion thereof, shall be considered to have passed the test if within twenty-four hours after the removal of the load such floor or roof recovers three quarters of the maximum deflection under the test load. If the member or portion of the structure shows evident failure or fails to meet the recovery requirement, it shall be rebuilt or may be modified as is necessary to make the structure adequate for the rated capacity, except that, where lawful, and where the structure is undamaged a lower rating may be established.

PART 24.

MASONRY.

Section 2401. Design of Masonry.—Masonry shall be designed by a method admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which it is subject without exceeding the stresses allowed in this chapter for the various materials thereof.

Sect. 2402. Materials of Masonry.—(a) The quality of materials assembled in masonry and the method and manner of their assembly shall be suitable for their use and shall conform to the minimum requirements of this chapter.

(b) The materials entering into masonry shall be classified for the purposes of this code as follows:—

(1) Brick.
(2) Stone.
(3) Cast Stone.
(4) Concrete Blocks.
(5) Structural Clay Tile.
(6) Gypsum Tile.
(7) Plain Concrete.
(8) Plain Gypsum Concrete.
(9) Mortar.

(c) A material of masonry other than those classified in this chapter, which is incombustible and otherwise sufficiently embodies the characteristics of one of the materials here classified, and which satisfies the requirements of

this chapter for that material may be included by the commissioner in the classification of that material which it most closely resembles.

(d) The commissioner may require reasonable tests from time to time of masonry to determine their quality and whether they conform to the requirements of this chapter.

(e) Tests of masonry or of the materials thereof shall be made in accordance with the standard specifications of the American Society for Testing Materials for testing the material in question and if for any material such standard specification is not available the commissioner shall specify the method and manner of making the test.

*Sect. 2403. **Brick.**— (a) Brick, as classified in this code, shall include masonry units usually about two and one quarter inches thick, three and three quarters inches wide and eight inches long. Brick shall be made of burned clay or shale, concrete, or a mixture of sand and lime.

(b) Burned clay brick shall be either solid or hollow, but if hollow shall be at least three quarters solid.

(c) Concrete brick shall be made of Portland cement, aggregates and water as specified for concrete in Part 26.

(d) Sand-lime brick shall be made of sand, lime, and water well mixed, pressed and cured in a carefully controlled process to a uniformly hard and durable product.

(e) Brick, whether of burned clay, concrete, or sand and lime, shall be classified for strength when tested flatwise according to the following table:—

Classification of Brick by Strength.

Grade.	Compressive Strength (Pounds per Square Inch).		Modulus of Rupture (Pounds per Square Inch).	
	Average of Five Tests.	Individual Minimum.	Average of Five Tests.	Individual Minimum.
A	4,500 or more	3,500	600 or more	400
B	2,500 to 4,500	2,000	450 or more	300

(f) Brick for load-bearing masonry or masonry exposed to the weather shall be of Grade A or B.

(g) Brick for fire protection, fire-resistive walls, or fire-stopping shall be of Grade B or better.

[**As amended by Ord. 1943, ch. 6*]

Sect. 2404. **Stone.**— Stone for masonry shall be hard and durable. Sandstone in masonry exposed to the weather shall be laid with its natural bed horizontal.

†Sect. 2405. **Cast Stone.**— (a) Cast stone shall be made of Portland cement, aggregates and water with or without admixtures. Cast stone for load-bearing masonry or exposed to the weather shall have an average com-

pressive strength at an age of twenty-eight days of at least five thousand pounds per square inch and shall have not more than seven nor less than three per cent water absorption by weight.

(b) Cast stone shall not project more than six inches beyond the supporting material. Cast stone shall have reinforcing as required for reinforced concrete in Part 26 of this code together with three inch damp-proofing protection of the reinforcing.

[†*As amended by Ord. 1943, ch. 6*]

Sect. 2406. Concrete Blocks.— (a) Concrete blocks, as classified in this Code, shall include hollow masonry wall units of concrete made from Portland cement, water and suitable aggregates, such as sand, gravel, crushed stone, bituminous or anthracite cinders, burned clay or shale and blast-furnace slag. The materials shall conform to the requirements for the materials of concrete specified in Part 26 except that cinder aggregate for concrete blocks shall contain not more than twenty per cent of combustible matter.

(b) Concrete blocks shall have outer shells at least five eighths inch thick and shall have strength in compression not less than two hundred and fifty pounds per square inch of gross area for an average of five blocks tested. Concrete blocks in load-bearing masonry or in masonry exposed to weather or soil shall have a strength in compression not less than one thousand pounds per square inch of gross area for an average of five blocks tested, and a minimum of seven hundred pounds per square inch for any block.

(c) Concrete blocks exposed to weather or soil in masonry shall have not more than twelve per cent water absorption by weight.

Sect. 2407. Structural Clay Tile.— (a) Structural clay tile shall consist of well burned hollow units of clay or shale.

(b) Structural clay tile shall be classified for use as follows:—
(1) Partition Tile.
(2) Floor Tile.
(3) Load-Bearing Tile.

(c) Structural clay partition tile shall be classified for physical quality as Grade A or Grade B according to the following table:—

Structural Clay Partition Tile.

Grade.	Water Absorption by Weight (per cent).		
	Average of Five Blocks.	Individual Maximum.	Individual Minimum.
A	5 to 16	19	4
B	16 to 25	28	4

(d) Structural clay partition tiles of the dimensions indicated shall have the construction and dry weights given in the following table:—

Structural Clay Partition Tile.

Dimensions (Inches).	Minimum Number of Cells.	Minimum Weight (Pounds).
2 x 12 x 12	3	14
3 x 12 x 12	3	15
4 x 12 x 12	3	16
6 x 12 x 12	3	22
6 x 12 x 12	4	25
8 x 12 x 12	4	30
10 x 12 x 12	4	35
12 x 12 x 12	4	40

(e) Structural clay partition tile shall not be used in load-bearing masonry. Partition tile exposed to the weather shall be Grade A. Partition tile in fire-resistive construction shall be Grade B or better. The exterior shells shall be at least five eighths inch and the interior webs at least one half inch thick.

(f) Structural clay floor tile shall be classified for physical quality as Grade A or Grade B according to the absorption table of paragraph (c) of this section for Structural Clay Partition Tile. Structural clay floor tile used in floor and roof arches shall have at least the physical qualities of the tile here classified as Grade B, as provided in Specifications for Structural Clay Floor Tile of the American Society for Testing Materials.

(g) Structural clay load-bearing tile shall be classified for physical quality as Grade A or Grade B according to the absorption table of paragraph (c) of this section, and the tile of each grade shall satisfy also the requirements for strength of the following table:—

Structural Clay Load-Bearing Tile.

Grade.	Compressive Strength (Pounds per Square Inch of Gross Area).			
	End construction.		Side construction.	
	Average of Five Blocks.	Individual Minimum.	Average of Five Blocks.	Individual Minimum.
A	1,400 or more	1,000	700 or more	500
B	1,000 or more	700	700 or more	500

(h) Tests to establish the grade of structural clay load-bearing tile shall be made as provided in Specifications for Structural Clay Load-Bearing Wall Tile of the American Society for Testing Materials.

(i) Structural clay load-bearing tile shall have the cellular construction and minimum weights given in the following table:—

Structural Clay Load-Bearing Tile.

THICKNESS IN WALL (INCHES).	Minimum Cells in Thickness of Wall.	Minimum Tile Weight per Square Foot (Pounds).
4	1	20
6	2	30
8	2	36
10	2	42
12	3	52

(j) Structural clay tile used in load-bearing masonry shall be load-bearing tile having at least the physical qualities of Grade B, and such tile in masonry exposed to weather or soil shall be of Grade A. Load-bearing tile shall have shells at least seven eighths inch and webs at least five eighths inch thick and shall otherwise conform to Specifications for Structural Clay Load-Bearing Wall Tile of the American Society for Testing Materials.

***Sect. 2408. Gypsum Tile.**— (a) Gypsum tile used for fire-resistive purposes shall conform to the provisions of Specifications for Gypsum Partition Tile or Block and Specifications for Gypsum of the American Society for Testing Materials.

(b) Gypsum tile shall not be used in load-bearing masonry or in masonry exposed to weather or soil.

***Sect. 2409. Plain Concrete.**— (a) Plain concrete is concrete cast in place and not reinforced, or reinforced only for shrinkage or changes of temperature. Plain concrete shall be mixed, placed and cured as specified for concrete in Part 26.

(b) Plain concrete in load-bearing masonry or where exposed to soil or where used for fire-resistive purposes, shall be of such proportions as to have a strength of at least fifteen hundred pounds per square inch and where exposed to wetting or freezing at least two thousand pounds per square inch as provided in Part 26.

[**As amended by Ord. 1943, ch. 6 and Ord. 1955, ch. 2*]

†Sect. 2410. Plain Gypsum Concrete.— (a) Plain gypsum concrete may be used for fire protection and non-structural purposes and shall contain not over fifteen per cent by weight of wood or other combustible binder.

[†*As amended by Ord. 1943, ch. 6*]

‡Sect. 2411. Mortar.— (a) Masonry, other than plain concrete and plain gypsum concrete, shall be laid in mortar except stone masonry in under-water masonry, in retaining walls not in buildings which may be laid without mortar. Load-bearing masonry laid in mortar shall have full beds and full builds of mortar in which the units are placed.

(b) Mortar shall consist of a mixture of suitable proportions of Portland ement, lime, sand and water; but approved special masonry cement may be ubstituted for the Portland cement or lime, or both.

(c) Portland cement and sand shall conform to the requirements for these materials in Part 26 of this code. Lime shall conform to Specifications for Quicklime for Structural Purposes or Specifications for Hydrated Lime for Structural Purposes of the American Society for Testing Materials.

(d) Lime putty shall be made by slaking to a smooth paste fresh and properly burned quicklime. The resultant paste shall be stored in a suitable box or other receptable for not less than forty-eight hours before being mixed with sand. Hydrated lime may be substituted in equivalent amount for lime putty.

(e) Lime mortar shall be composed of one part of lime putty and not over three parts of sand by volume. Portland cement may be added to lime mortar, replacing an equal volume of lime putty, and when the cement is not less than one half the lime by volume, the working stress allowed in the masonry may be increased proportionally up to the stress specified for lime-cement mortar.

(f) Lime-cement mortar Class A shall be composed of one part of lime putty, one part of Portland cement and not more than six parts of sand by volume. Portland cement may be added to lime-cement mortar replacing an equal volume of lime putty, and when such addition is made, the working stress allowed in the masonry may be increased proportionally up to the stress specified for cement mortar.

(g) Lime-cement mortar Class B shall be composed of two parts lime putty, one part of Portland cement and not more than eight parts of sand by volume. Portland cement may be added to lime-cement mortar replacing an equal volume of lime putty, and when such addition is made, the working stress allowed in the masonry may be increased proportionally up to the stress specified for cement mortar.

(h) Cement mortar shall be composed of one part of Portland cement and not more than three parts of sand by volume with an allowable addition of lime putty or hydrated lime not to exceed fifteen per cent by volume of the cement content.

(i) Mortar made of so-called "Masonry Cement" may be used. The unit stress allowed in masonry laid with such mortar shall be determined by the commissioner after tests or other satisfactory evidence have been submitted to him, but the unit stress shall not be greater than that given in section twenty-four hundred and thirteen for masonry laid in lime-cement mortar.

(j) In proportioning mortar a sack of Portland cement weighing about ninety-four pounds shall be taken as one cubic foot and the volume of the sand shall be based on dry and loose measurement.

(k) Except as otherwise provided in paragraph (a) of this section load-bearing masonry, party walls, fire walls and masonry exposed to weather or soil shall be laid in lime mortar, lime-cement mortar, cement mortar or

approved masonry cement mortar. Hollow masonry walls and masonry of hollow units shall be laid in lime-cement mortar, cement mortar or approved masonry cement mortar. Masonry likely to be under water or in contact with wet soil, if laid in mortar, shall be laid in cement mortar. Mortar or grout under metal bases of columns or beams resting upon concrete shall be made without lime.

(l) Gypsum tile walls and other non-bearing masonry walls may be laid in gypsum mortar.

[‡*As amended by Ord. 1943, ch. 6*]

Sect. 2412. Bond in Masonry.— Masonry walls and piers shall be bonded as provided in Part 14.

***Sect. 2413. Allowable Unit Stresses in Masonry.**—(a) In masonry walls and piers subject to axial loads the average unit compressive stress shall not exceed the values given in the following table:—

Average Unit Compressive Stress in Masonry.
(Pounds Per Square Inch, Gross Area.)

Masonry.	Lime Mortar.	Lime-Cement Mortar.		Cement Mortar.
		Class A.	Class B.	
Brick:				
Grade A	100	200	180	300
Grade B	75	150	130	225
Cut Stone:				
Granite, Limestone, Marble, Sandstone	300	450	400	600
Cast Stone, Rubble Stone	100	200	180	300
Concrete Blocks	—	100	90	150
Structural Clay Tile:				
Load-Bearing Tile	—	80	70	100
Floor Tile	—	80	70	100

The compressive unit stress in plain concrete shall not exceed one fifth the compressive strength at twenty-eight days when determined as specified in Part 26.

(b) The unit shear in masonry shall not exceed one tenth the allowable unit compressive stress.

(c) The maximum unit stress in bending in sound natural stones used in lintels, foundations, retaining walls and elsewhere shall not exceed the values given in the following table:—

Maximum Unit Stress in Bending.
[Pounds Per Square Inch.]

Granite	180
Limestone	140
Marble	120
Sandstone	100

The maximum unit stress in bending in plain concrete shall not exceed one fiftieth the compressive strength at twenty-eight days when determined as specified in Part 26.

(d) The unit bearing stress in masonry under supported beams, columns and other concentrations, and the maximum unit stress in masonry walls and piers including stress due to calculated bending and eccentric loading shall not exceed by more than twenty-five per cent, the allowable average stresses given in this section.

(e) In hollow walls or in masonry of hollow units, solid masonry shall be provided under concentrations of load to transmit the load without excessive stress.

(f) Masonry bearing walls shall have at least the thickness specified in Part 14.

[**As amended by Ord. 1943, ch. 6*]

†**Sect. 2414. Plain Masonry Arches.**— (a) Masonry arches shall be so designed that the line of thrust under all loadings lies within the middle third of the structural arch, or arch ring. Abutments shall be provided capable of resisting the horizontal as well as the vertical component of the thrust without settlement which would permit the line of thrust to depart from the middle third of the arch ring.

(b) The horizontal component of the arch thrust may be resisted by metal ties so placed that the horizontal component furnished by the ties combined with the vertical supporting reaction shall be in line with the arch thrust.

(c) In the design of tie rods and beams to resist the thrust of successive masonry floor arches, the load producing the thrust shall be considered to be the live load for interior panels and the total load for exterior panels.

[†*As amended by Ord. 1943, ch. 6*]

‡**Sect. 2415. Reinforced Masonry.**—Lintels in masonry walls, and other approved structures, may be constructed of reinforced masonry when designed and constructed in a manner consistent with the provisions of Parts 26 and 28 of this code.

[‡*As amended by Ord. 1943, ch. 6*]

Sect. 2416. Second-Hand Materials for Masonry.— Second-hand brick, stone, blocks and other masonry units shall not be used in masonry unless they conform to the requirements of this code and have been thoroughly cleaned.

PART 25.

WOOD.

Section 2501. Design of Wood.—(a) Structures of wood shall be designed by methods admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which they are subject without exceeding the stresses allowed in this part for the various grades and species of wood.

(b) Wooden structural members shall be so framed, tied, braced and anchored as to develop the strength and rigidity necessary for the purposes for which they are used.

(c) Walls and partitions of wood shall conform to the provisions of Part 14. Floor and roof construction shall conform to the provisions of Parts 16 and 17 respectively. Wood near chimneys and heating apparatus shall conform to the provisions of Part 21.

(d) Except as otherwise provided in Part 29, wood shall not be used in the foundation of a structure. Except as otherwise provided in Parts 14, 16 and 17, wood shall not be used to support masonry.

Sect. 2502. Quality of Lumber.— Structural wood of the species listed in the tables of allowable unit stresses in section twenty-five hundred and four shall conform to the requirements for the several grades in specifications or grading rules of regional associations of lumber manufacturers which are based upon the grading procedure of American Lumber Standards in Simplified Practice of the United States Department of Commerce and the Guide to the Grading of Structural Timbers and the Determination of Working Stresses (Miscellaneous Publication No. 185 of the United States Department of Agriculture). The lumber of the several grades and species shall be so specified as to justify the allowable stresses in accordance with the said Guide to the Grading of Structural Timbers and the Determination of Working Stresses.

*Sect. 2503. **Lumber Sizes and Grades.**—(a) The minimum sizes of structural members of wood specified in this part refer to net sizes, for which American Lumber Standard dressed sizes shall be accepted as minimum. For convenience nominal sizes may be shown on the plans submitted with applications to the commissioner for permit, provided that computations of stresses in wood members used structurally shall be determined by the net finished sizes of lumber and timber employed. The actual dimensions of greater rough and/or dressed sizes of lumber supplied may be computed for strength provided such sizes are specified or shown on the drawings.

(b) The species, classification and grade of all wood used structurally shall be specified on the drawings filed with the commissioner.

[**As amended by Ord. 1943, ch. 6*]

†Sect. 2504. **Allowable Unit Stresses in Wood.**—(a) The unit stress in wooden structural members of the several species and grades shall not exceed the allowable values specified in the following tables computed on the net cross section, except stresses due to wind impact and temporary loads and as otherwise provided in this section.

[*The tables which in law follow here are, for typographical reasons, reproduced on pages 178 to 181, inclusive.*]

The working stresses listed in the tables are allowed for lumber in continuously dry locations, for pressure impregnated lumber and timber with approved preservative toxics, and for wet timbers below mean low water level. Compression across the grain in untreated lumber used in damp locations, alternately wet and dry or wholly wet shall not exceed seventy per cent of the values shown in Table I. In structures such as bridges in the open, trestles, towers and *reviewing* stands, the allowable unit stresses, except for shear and rigidity, in untreated lumber and timbers shall be reduced to eighty-five per cent of the unit stresses listed and in untreated structures more or less continuously damp or wet such unit stresses shall not exceed seventy-five per cent.

(b) Except for form-work, sewer and trench dynnage and other temporary purposes, sheathing, inaccessible attic joists, lumber and timber used structurally or for load bearing purposes shall be of the grades and species listed in accompanying Tables I and II and their corresponding allowable unit stresses, in pounds per square inch, computed on the basis of actual dimensions, shall not be exceeded except as herein modified for impact, wind, etc. Those species, grades and corresponding stresses not included in Tables I and II shall be established by the commissioner on the basis of miscellaneous publication now known as No. 185 "Guide to the Grading of Structural Timbers and Determination of Working Stresses" and supplement thereto of the United States Department of Agriculture.

(c) In wooden members subject to axial tension the tensile stress shall not exceed the allowable stress in bending. Compression parallel to the grain shall not exceed the stress allowed in short columns.

(d) The unit stress in wooden structural members due to wind alone or in combination with static live and dead loads shall not exceed by more than one half the allowable stresses specified in this section.

(e) When the unit stress in wooden structural members due to impact does not exceed that due to static live load the members need not be increased in size on account of impact. When the stress due to impact exceeds that due to static live load, the unit stress in the member due to impact and dead load combined shall not exceed the allowable stresses specified in this section.

(f) All structural lumber shall be grade marked or other evidence satisfactory to the commissioner shall be submitted verifying its appropriate grade. Salvaged lumber, if it meets grading requirements, may be used.

(g) Temporary Structures.

1. In temporary structures and structures subject to loading for short periods allowable stresses may be exceeded by not more than fifty per cent in the discretion of the commissioner.

2. In joists supported on a ribbon or ledger board and spiked to the studs, the allowable unit stress in compression across the grain may exceed the allowable stresses specified in this section by not more than one half.

3. The unit stress in compression across the grain in a limited area not over six inches long along the grain nor less than three inches from the ends of the timber may exceed the allowable stresses specified in this section by not more than the following percentages:

Length of Bearing (Inches).	Percentage Excess.
1/2	85
1	60
1 1/2	45
2	30
3	15
4	10
6 or more	None

Intermediate values shall be determined by interpolation. The bearing stress under a washer or small plate shall not exceed that provided in this paragraph for a bearing the length of which equals the diameter of the washer or plate.

A. Temporary structures as considered above shall be removed within one year.

(h) Unit compressive stress on a surface inclined to the grain shall not exceed the following value:—

$$\frac{C\,Q}{C\,\mathrm{Sin}^2\,\theta + Q\,\cos^2\,\theta}$$

in which (C) is the allowable unit compression parallel to the grain.

(Q) is the allowable unit compression across the grain.

(θ) is the angle between the direction of the pressure and the direction of the grain.

(i) The allowable unit shear specified in this section is based upon the maximum amount of checking, due to shakes or seasoning, permitted by the grading rules for each species. Lumber with greater checking than is permitted in the grading rules may be used in structures with the approval of the commissioner, provided the unit shear is proportionately less than the allowable values specified in this section.

(j) The unit shear in joint or connection details of wooden trusses or framing may exceed the values specified in this section by not exceeding fifty per cent.

[†*As amended by Ord. 1943, ch. 6 and Ord. 1955, ch. 2*]

‡**Sect. 2505. Wooden Columns.**— (a) The average unit compression in wooden columns axially loaded shall not exceed the values specified in section twenty-five hundred and four, depending upon the ratio of length to least net dimension. Intermediate values shall be determined by interpolation. The ratio of length to least dimension shall not exceed fifty.

(b) The axial load on a wooden column of round cross-section shall not exceed that allowed on a square column of the same cross-sectional area.

(c) The least lateral dimension of a tapered column for determining its slenderness ratio shall be measured at a point one third the length from the small end but shall not be taken as more than three halves the least dimension at the small end. The average unit compression at the small end shall not exceed the allowable stress for a short column.

(d) Built up wooden columns of several adequately seasoned pieces shall have each well spiked, screwed, glued, or bolted together with approved mechanical connectors. Solid laminated columns shall have boards or planks coverplated securely to the edges of all laminations.

(e) In a built up wooden column subject to axial load the average unit compression shall not exceed three quarters of the allowable stress specified in section twenty-five hundred and four nor shall its load exceed the allowable load of a solid rectangular wooden column of which the moment of inertia about each principal axis is equal to the sum of the moments of inertia of the several pieces of the built up column about corresponding axes.

(f) Wooden columns and posts shall be squared at the ends at right angles to their axes.

(g) Wooden columns resting upon concrete or masonry which is in contact with the ground shall be separated from such concrete or masonry by an effectual seal to prevent moisture from reaching the wood through capillary action.

[‡*As amended by Ord. 1943, ch. 6*]

*Sect. 2506. **Wooden Beams.**— (a) In computing the maximum unit shear in wooden beams the effect of loads not further from the center of the support than the depth of the beam may be neglected.

(b) Wooden beams notched at the end supports shall not be so loaded that the unit shear exceeds the allowable value specified in section twenty-five hundred and four when computed by the following formula—

$$\frac{3\,V\,h}{2\,b\,d^2}$$

in which (V) is the shear.

(h) is the total depth of the beam.

(b) is the breadth of the beam.

(d) is the depth of the beam from the bottom of the notch to the opposite face.

(c) Unless the local unit stress is calculated and found to be not in excess of allowable stresses specified in section twenty-five hundred and four, wooden beams shall not be cut, notched or bored to clear pipes, wires, conduits or for other purposes except as follows: —

(1) Notches may be cut in the top or bottom not deeper than one fifth the depth of the beam and not further from the support than one fifth the span.

(2) Holes may be bored in the middle third of the depth and length not larger in diameter than one quarter the depth.

(3) Holes may be bored elsewhere in the piece limited as to size and placement the same as knots in the grade of lumber used, having due regard to the existence of knots in the piece.

(d) Trimmers, tail joists and headers more than eight feet long or more than four feet long where the live load exceeds fifty pounds per square foot unless framed on top of supporting beams, shall be hung in approved stirrup irons or joist hangers.

(e) In wooden floor and roof construction where the depth of joists is more than three times the thickness, and where the span is greater than eight feet, bridging shall be placed between joists not less than eight feet apart nor less than eight feet from supports. Cross-bridging shall not be less than two square inches in net cross-section; and where the live load is greater than fifty pounds per square foot, not less than four square inches.

(f) Joists doubled under bearing partitions shall be well spiked together or separated by solid bridging not more than sixteen inches apart.

(g) Beams built up of timbers shall be firmly bolted together. Bolts shall be staggered and spaced longitudinally not further apart than four times the depth of the beam.

(h) Where wooden girders or beams meet at columns they shall be fitted around the columns or butted up close, and unless the post caps or bolsters provide sufficient anchorage, shall be held in place and tied through to form a continuous tie across the building sufficient to resist the wind pressure

specified in Part 23 applied outwardly to the walls. Where wooden beams are supported by girders they shall be tied to form a similar continuous tie across the building.

(i) Wooden beams or girders resting upon masonry walls, or parallel to masonry walls, and nailing pieces for planking or boarding supported by masonry walls, shall be bolted or otherwise anchored to the walls in such a manner as to resist the wind pressure specified in Part 23 applied outwardly to the walls.

(j) Joists supporting a live floor or roof load not more than forty pounds per square foot and supported at the ends by a wooden girder, may rest upon a wooden strip or cleat, not less than one and one half by three and one half inches, well spiked or otherwise secured to the girder. Such joists supporting heavier loads shall rest on top of the girder or be hung in approved joist hangers.

(k) Nailing strips for the support of wooden joists or planking on a steel girder or beam shall be bolted to the web of the girder or beam. Where the live load exceeds forty pounds per square foot the nailing strip shall be bolted to the girder or beam and shall rest upon the flanges or upon shelf angles attached to the web which provide a three-inch bearing or upon other approved support.

(l) The ends of wooden beams or girders resting upon masonry or concrete exterior, party or fire walls shall be separated from the opposite face of the wall and from beams entering the opposite face of the wall by at least four inches of solid masonry or concrete.

[**As amended by Ord. 1943, ch. 6*]

Sect. 2507. Wooden Floors and Roofs.— (a) Wood shall not be used in the first floor of a building where there is not a basement or cellar below, unless it has clearance above the ground of at least twenty-four inches, and the space below is ventilated either to a heated basement or to the outside air. Ventilation of such space to a heated basement shall consist of at least two remote openings in the basement wall having a total area of at least two square feet for each twenty-five linear feet of wall. Ventilation of such space to outside air shall consist of one or more openings in each exterior wall thereof, well distributed, except that openings need not be provided in the front wall when the space is ventilated in the rear and both side walls. The aggregate area of openings shall be not less than two square feet for each twenty-five linear feet of wall. Openings in exterior walls shall be protected by non-corrodible wire mesh with openings not greater than one half inch.

(b) Rough or sub-floor boards in buildings of Type IV or Type VI shall be laid across the joists at an angle of not less than forty-five degrees. Each board shall be nailed twice at each joist. The sub-flooring shall extend to and be fitted to the rough walls and partitions.

(c) Floor boards and planking shall not penetrate a party or fire wall nor extend through a doorway in a party or fire wall. Roof boarding and planking shall not penetrate or extend over a party or fire wall.

†**Sect. 2508. Wooden Walls and Partitions.**— (a) Wooden stud bearing walls shall be designed to support their vertical loads without assistance from boarding or other wall covering. Bridging and other bracing shall be provided as may be necessary for this purpose and otherwise as provided in Part 14.

(b) Floor or roof girders, hip and valley rafters framing on exterior stud walls shall be supported by adequate posts.

(c) Stud partitions containing plumbing, heating or other pipes shall be so framed and the joists beneath so spaced as to provide proper clearance for the piping. Where a partition containing such piping is parallel to supporting floor joists, the joists shall be doubled under the partition, spaced to clear the piping and bridged with solid bridging.

(d) All concealed openings through floors shall be fire-stopped as provided in section 2202, paragraph (i) of this code.

[†*As amended by Ord. 1943, ch. 6*]

Sect. 2509. Wood Framing.— (a) In bolted connections of wooden trusses or framing the center of a bolt shall not be less than twice its diameter from the edge of the member. In the direction of the force transmitted the distance from the edge shall be such that the unit shear shall not exceed the allowable shear specified in section twenty-five hundred and four. The bolt shall fill the hole completely without splitting the timber. Bolts with rolled threads shall not be used in shear. Bolt threads shall be full and clean and of sufficient length to allow the nut to be screwed up tight. Washers shall be used under nuts and, except on carriage bolts, under heads. Nuts shall be concentric.

(b) Timber joints in which other fastening devices and connectors are used shall be designed and framed in accordance with good engineering practice.

STRUCTURAL LUMBER — WORKING STRESSES:

TABLE 1.— GIRDERS, STRINGERS, BEAMS, JOISTS & PLANK — PERMANENT LOADS.

SPECIES AND STRESS GRADES	COMMERCIAL GRADE NAMES	RULES UNDER WHICH GRADED	Pounds per Sq. Inch of Net Section (a)			
			Extreme Fibre in Bending & Tension (b)	Horizontal Shear (Max.)	Compression $\perp$ to Grain	Modulus of Elasticity Stiffness Factor
CEDAR, Western Red 1000 #f	Structural	W. C. Lbrmns. Assn.	1000	100	200	1,000,000
CYPRESS, Tidewater Red 1400 #f 1100 #f	1400 #f Tdwtr. Red 1100 #f " "	Sou. Cypress Mfrs. Ass'n.	1400 1100	120 100	300	1,200,000
DOUGLAS FIR COAST REGION 1800 #f Dense 1600 #f Close-grnd. 1200 #f 900 #f	Dense Sel'ct. Str'l. Select Structural 1200 #f Framing & J'st. 900 #f " "	West Coast L'brmns. Ass'n.	1800 1600 1200 900	120 100 100 100	380 345 325 325	1,600,000
HEMLOCK (Eastern) 1100 #f " " 900 #f	Select Structural 900 #f Strgt. Grained.	No. Hemlock & Hdwood Mfrs. Ass'n.	1100 900	70 52	300	1,160,000
HEMLOCK (West Coast) 1040 #f	No. 1 Dimension	W. C. L'brmns. Ass'n.	1040(c)	100	300	1,400,000
LARCH 1800 #f Dense 1600 #f Close-grained 1200 #f	Select Structural Structural Common Structural	Western Pine Association	1800 1600 1200	120 100 100	380 345 325	1,300,000

OAK, Red & White	1800 #f 1600 #f 1400 #f 1200 #f	1800 #f Red & White 1600 #f " " 1400 #f " " 1200 #f " "	National Hard-wood Lumber Association	1800 1600 1400 1200	120 120 120 100	500	1,500,000
PINE, LONGLEAF SOUTHERN	2000 #f Dense 1800 #f " 1600 #f " 1400 #f " 1050 #f "	Select Structural Prime " Merch'ble " or Strl. Sq. Edge & Sound No. 1 Structural or No. 1 L. L. Dimension No. 2 L. L. 1050 #f Dim'n.	Southern Pine Inspection Bureau of the Southern Pine Association.	2000 1800 1600 1400 1050	100	380	1,600,000
PINE, SHORTLEAF SOUTHERN	1600 #f Dense 1400 #f " 1200 #f " 1050 #f Dense 900 #f "	Str'l. Sq. Edge & Sound. Dense No. 1 Structural or No. 1 Dense Dimension. No. 1 Dimension No. 2 Dense 1050 #f Dim. No. 2 Med. Gr'n. 900 #f "		1600 1400 1200 1050 900	100	380	1,600,000
PINE, NORWAY	1000 #f 900 #f	1000 S. G. 900 S. G.	No. Hemlock & Hard-wood Mfrs. Ass'n.	1000 900	64 64	300	1,200,000
REDWOOD	1600 #f Close grain 1400 #f " " 1200 #f " "	1600 #f Close grain Dense Sel'ct. All-Ht. Select All-Heart	California Redwood Association	1600 1400 1200	80 80 70	267	1,200,000
SPRUCE, Eastern Structural	1200 #f 1100 #f 1000 #f	1200 #f Str'l. Spruce 1100 #f " " 1000 #f " "	Northeastern Lbr. Mfrs. Association	1200 1100 1000	90 80 80	250	1,200,000

(a) For Stresses in Compression Parallel to Grain, See TABLE 2 following.
(b) For Tension Parallel to Grain ONLY. GRADING PROCEDURE — MISC. PUBL'N. #185.
(c) With Slope of Grain restricted, not to exceed 1 in 10.

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STRUCTURAL LUMBER — WORKING STRESSES.

TABLE 2.— POSTS, COLUMNS & COMPRESSION MEMBERS — PERMANENT LOADS.

Species & Stress Grades	Commercial Grade Names	Rules Under Which Graded	Compression Parallel to grain in Pounds per Sq. Inch of Net Cross Section — for Length to Least Dimension L/d of: Short posts	14	17	20	23	26	30	35	40	50
CEDAR, Western Red 800 #C	Structural.	W. C. Lbrmns. Ass'n.	800	762	716	638	619	405	304	223	170	109
CYPRESS, TIDEWATER RED 1200 #C 1000 #C	1200 #C TDWTR. RED 1000 #C " "	SOUTH'N CYPRESS MFRS. ASSOC'N.	1200 1000	1110 947	1003 885	822 780	622	486	365	268	206	132
DOUGLAS FIR Coast Region 1300 #C Dense 1200 #C Clse. Grn. 1100 #C 880 #C	Dense Select Strl. Select Structural. No 1 Timbers No 1 Dimension	WEST COAST LUMBERMEN'S ASSOCIATION	1300 1200 1100 880	1235 1148 1060 860	1158 1088 1015 837	1030 986 937 796	829 827 811 705	649	487	358	274	175
HEMLOCK, Eastern 700 #C	Select Structural	NO HEMLK & HDWD. MFRS.	700	678	653	611	554	446	335	246	188	121
HEMLOCK, West Coast 720 #C	No 1 Dimension	W. C. Lbrmns. Assn.	720	706	688	660	615	549	448	313	240	153
LARCH Dense 1466 #C Clse. Grn. 1200 #C 1100 #C	Select Structural Structural Common Structural.	WESTERN PINE ASSOCIATION	1466 1200 1100	1325 1121 1041	1160 1032 971	891 878 854	673	527	396	291	223	142

OAK, Red White	1100 #C 1000 #C 900 #C	1100 #C Red & White 1000 #C " " 900 #C " "	NATIONAL HARDWOOD LUMBER ASSOCIATION	1100 1000 900	1055 966 876	1003 926 847	914 859 798	774 763 722	608	457	336	257	164
PINE, Dense Longleaf Southern	1450 #C 1300 #C 1200 #C 1200 #C 1000 #C	Select Structural Prime Structural Merch'ble Structural Strl. Sq. Edge & Snd. No 1 Structural	SOUTHERN PINE INSPECTION BUR- EAU OF THE SOUTH- ERN PINE ASS'N.	1450 1300 1200 1000	1360 1235 1148 970	1255 1158 1088 935	1076 1030 986 876	829 829 827 783	649	487	358	274	175
PINE, Dense Shortleaf Southern	1450 #C 1300 #C 1200 #C 1000 #C	Dense Select Strl. Dense Structural Dense Strl. Sq. E. & Sd. Dense No. 1 Strl.		1450 1300 1200 1000	1360 1235 1148 970	1255 1158 1088 935	1076 1030 986 876	829 829 827 783	649	487	358	274	175
REDWOOD	1200 #C Clse. Grained 1100 #C " " 1000 #C " "	1200 #C Clse. Grained 1100 #C " " 1000 #C " "	CALIFORNIA REDWOOD ASSOCIATION	1200 1100 1000	1110 1031 947	1003 948 885	822 810 780	622	486	365	268	206	132

PART 26.

REINFORCED CONCRETE.

Section 2601. Design of Reinforced Concrete.— Reinforced concrete shall be designed by methods admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which it is subject without exceeding the stresses allowed in this part for the various materials thereof.

***Sect. 2602. Definitions Pertaining to Reinforced Concrete.**—(a) The following terms are defined for use in this part of the code:—

Aggregate: Inert material used as a filler in concrete.

Blast-Furnace Slag: The non-metallic product, consisting essentially of silicates and alumino-silicates of lime, which is developed simultaneously with iron in a blast furnace.

Column: An upright compression member the length of which exceeds three times its least lateral dimension, excluding piles and caisson piers.

Column Capital: An enlargement of the upper end of a reinforced concrete column designed and built to act as a unit with the column and flat slab. A framework of metal for the same purpose.

Column Strip: A portion of a flat slab panel one half panel in width occupying the two quarter-panel areas outside of the middle strip. (See Middle Strip.)

Combination Column: A column in which a structural steel section, designed to carry the principal part of the load, is encased in concrete in such a manner that some additional load may be allowed.

Composite Column: A column in which the structural steel or cast iron column designed to carry the principal part of the load is encased in concrete containing reinforcement of spiral and longitudinal steel.

Concrete: A mixture of Portland cement, fine aggregate, coarse aggregate and water.

Diameter: The diameter of a square bar shall be the distance between opposite sides. The diameter of a deformed bar shall be the diameter of a plain bar having the same area of cross-section.

Dropped Panel: The structural portion of a flat slab which is thickened throughout an area surrounding the column capital.

Effective Area of Concrete: Of a cross-section, the area which lies between the centroid of the tensile reinforcement and the compression surface in a beam or slab, and having a width equal to the width of the rectangular beam or slab, or the effective width of the flange of a T-beam.

Effective Area of Reinforcement: The area obtained by multiplying the right cross-sectional area of the metal reinforcement by the cosine of the angle between its direction and that for which the effectiveness of the reinforcement is to be determined.

Flat Slab: A concrete slab reinforced in two or more directions generally without beams or girders to transfer the loads to columns.

Hook: A hook made by bending a length at the end of a bar one hundred and eighty degrees about a pin of a diameter not less than five nor more than eleven bar-diameters, with a straight extension of at least four bar-diameters at the free end.

Laitance: Extremely fine material of little or no strength which may collect on the surface of freshly deposited concrete or mortar, usually recognized by its relatively light color.

Middle Strip: A portion of a flat slab panel one half panel in width, symmetrical with respect to the panel center line and extending through the panel in the direction in which bending moments are being considered.

Paneled Ceiling: The ceiling of a flat slab in which approximately that portion of the area enclosed within the intersection of the two middle strips is reduced in thickness.

Panel Length: In a flat slab, the distance along a panel side from center to center of columns.

Pedestal: An upright compression member whose height does not exceed three times its least lateral dimension.

Pedestal Footing: A column footing projecting less than one half its depth from the faces of the column on all sides and having a depth not more than three times its least width.

Portland Cement: The product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

Ratio of Reinforcement: The ratio of the effective area of the reinforcement cut by a section of a beam or slab to the effective area of the concrete at that section.

Reinforced Concrete: Concrete in which metal other than that provided for expansion and contraction, is embedded in such a manner that the two materials act together in resisting forces.

Screen: A metal plate with closely spaced circular perforations.

Sieve: Woven wire cloth or a metal plate with square openings of uniform size.

Strut: A compression member other than a column or pedestal.

Water-Cement Ratio: The total quantity of water entering the concrete mixture, including the surface water carried by the aggregate, expressed in terms of the quantity of cement. The water-cement ratio shall be expressed in U. S. gallons per bag (ninety-four pounds) of cement.

(b) The symbols and notations used in this part are defined as follows:

a—Angle between inclined web bars and axis of beam.

A—Total area of pedestal, pier, or footing at the column base.

A′—Loaded area of pedestal, pier, or footing at the column base.

A_c—Total area of the concrete section $= A_g - A_r$.

A_r—The cross-sectional area of the steel column.

A_g—Gross area of concrete column.

A_s—Effective cross-sectional area of steel in tension in beams and slabs, or compression in columns.

A_v—Total area of cross-section of one unit of web reinforcement.

b—Width of rectangular beam or width including flange of T-beam.

b′—Thickness of web in beams of I or T section.

c—Diameter of column capital of a flat slab.

c′—The distance from gravity axis to extreme fiber in compression.

C—The ratio of f_a to the allowable fiber stress for members in flexure.

C_o—In two-way slab design, coefficient dependent on position of panel relative to adjacent continuous panels.

C_1—Coefficient for bending dependent upon continuity and restraint.

d—Depth of beam or slab from compression face to center of longitudinal tensile reinforcement.

d′—Least lateral dimension of a column.

e—The eccentricity of resultant load, measured from the gravity axis.

E_c—Modulus of elasticity of concrete in compression.

E_s—Modulus of elasticity of steel (thirty million pounds per square inch).

f_a—Average allowable stress on an equivalent axially loaded concrete column.

f_c—Compressive unit stress in concrete.

f'_c—Ultimate compressive strength of concrete at age of twenty-eight days.

f'_r—The allowable stress for unencased steel column.

f_s—Tensile unit stress in longitudinal reinforcement.

f'_s—The useful limit stress of spiral reinforcement. See Sec. 2671, par. (d).

f_v—Tensile unit stress in web reinforcement.

g—Sum of perimeters of bars in one set.

h—Unsupported length of column.

I—Moment of inertia of a section about the neutral axis for bending.

j—Ratio of arm of resisting couple in bending to depth (d).

L—Span length of beam or slab; length or width of flat slab panel.

L_1—Length of width of a two-way or flat slab panel at right angles to the direction in which bending is considered.

M—Bending moment or moment of resistance in general.

M_o—Sum of positive and negative bending moments at the principal design sections of a panel of a flat slab.

n—Ratio of modulus of elasticity of steel to that of concrete (E_s/E_c).

p—Ratio of effective area of tensile reinforcement in bending.

p′—Ratio of volume of spiral reinforcement to the volume of the concrete core (out to out of spirals).

p_g—Ratio of the effective cross-sectional area of vertical reinforcement to the gross area A_g.

P—Total safe axial load on a short column.

P′—Total safe axial load on a long column.

r—Ratio of breadth to span of panel of a two-way slab.

R—Least radius of gyration of a column section or equivalent concrete section.

s—Spacing of web reinforcement measured along the axis of the beam.

s′—Distance from the center of a concentrated load to nearer support of a slab.

t—Thickness of flange of T-beams.

t′—The overall depth of section.

t_1—Thickness of flat slab near column (including dropped panel, if any);

t_2—Thickness of flat slab outside the dropped panel.

u—Bond stress per unit of surface area of bar.

v—Shearing unit stress.

V—Total shear at a cross-section.

V′—Excess of the total shear over the allowed resistance in shear of the concrete unreinforced.

w—Uniformly distributed load per unit length of beam or slab or per unit area.

w′—Actual width of a concentrated load upon a slab.

W—Total uniformly distributed load in a single panel area.

[**As amended by Ord. 1943, ch. 8*]

Sect. 2603. Inspection of Concrete.— The commissioner shall require an applicant for a permit involving the structural use of concrete to have a competent inspector at all times on the work while such concrete is being proportioned, mixed and deposited.

Sect. 2604. Tests of Materials of Reinforced Concrete.— The commissioner shall have the right to require reasonable tests from time to time to determine whether the materials and methods in use are such as to produce reinforced concrete of the necessary quality. Copies of the reports of such tests shall be kept readily available by the commissioner for a period of two years after the completion of the structure.

Sect. 2605. Cement.— (a) Portland cement shall conform to the Standard Specifications and Tests for Portland Cement of the American Society for Testing Materials.

(b) Special cement may be used for Portland cement, subject to the approval of the commissioner, provided it meets the requirements for Portland cement in regard to strength, soundness and setting time.

Sect. 2606. Concrete Aggregates.— (a) Concrete aggregates shall consist of graded natural sands and gravels, crushed rock, or other inert materials having clean, uncoated grains of strong and durable minerals. Aggregates containing soft, friable, thin, flaky, elongated or laminated particles totaling more than three per cent, or containing shale in excess of one and one half per cent, or silt and crusher dust finer than the number one hundred standard sieve in excess of two per cent, shall not be used. These percentages shall be based on the weight of the combined aggregate as used in the concrete. When all three groups of these deleterious materials are present in the aggregates, the combined amounts shall not exceed five per cent by weight of the combined aggregate.

(b) Burnt shale or clay, cinders, slag or other hard, clean, inert, artificial materials may be used as concrete aggregates, subject to the approval of the commissioner, provided they contain not more than one per cent by weight of sulphur or similar compounds (free or combined), nor more than ten per cent by weight of combustible matter, are properly prepared by crushing and screening to give a graded coarse and fine aggregate, and come from a source that is known to give uniform quality.

(c) Fine aggregate shall not contain organic material sufficient to give a color darker than the standard color when tested in accordance with the Standard Method of Test for Organic Impurities in Sands for Concrete of the American Society for Testing Materials.

(d) Coarse aggregate shall not be larger than one fifth of the narrowest dimension between forms of the member in which the concrete is to be used, nor larger than three fourths of the minimum clear spacing between reinforcing bars. By maximum size of aggregate is meant the smallest sieve size through which eighty-five per cent by weight of the materials can be passed. Aggregate larger than one inch of sandstone, granite, quartzite and siliceous gravel shall not be used in fire-protective concrete.

(e) Fine aggregate shall consist of all particles passing a number four sieve.

Sect. 2607. Water in Concrete.—Water used in mixing concrete shall be free from injurious amounts of acids, salts, alkalies or organic materials.

Sect. 2608. Metal Reinforcement.—(a) Metal reinforcement shall be steel bars conforming to the requirements of the Standard Specifications for Billet-Steel Concrete Reinforcement Bars of Structural or Intermediate Grade, or for Rail-Steel Concrete Reinforcement Bars of the American Society for Testing Materials, or rerolled bars, whether from rails or from other suitable approved sections, which otherwise meet the requirements of one of the three specifications, or wire or expanded metal. The provision in these specifications for machining deformed bars before testing shall be disregarded. The tests called for in the said specifications shall always be made when rerolled steel is used.

(b) Wire for concrete reinforcement shall conform to the requirements of the Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement of the American Society for Testing Materials.

(c) Structural steel shall conform to the requirements of Part 28.

(d) Cast-iron sections for composite columns shall conform to the requirements of Part 28.

(e) Deformed bars shall have closely spaced shoulders, lugs or projections formed integrally in rolling, of such nature as to produce a bond or resistance to slipping when embedded in concrete, at least twenty-five per cent greater than that of plain hot-rolled round bars. Wire mesh with welded intersections not further apart than twelve inches (six inches in web reinforcement) in the direction of the principal reinforcing, and with cross wires of at least number ten gage, or expanded metal, may be rated for bond as deformed bars.

Sect. 2609. Storage of Materials for Concrete.—Cement and aggregates shall be stored at the work in a manner to prevent deterioration or the intrusion of foreign matter. Any material which has deteriorated or has been damaged shall not be used in concrete.

Sect. 2610. Concrete Quality.—(a) The allowable unit stresses for the design of reinforced concrete structures shall be based upon the twenty-eight-day strength of the concrete to be used in the structure in accordance with the values given in section twenty-six hundred and twenty-nine. Plans submitted for approval or used on the work shall clearly show the strength of concrete for which all parts of the structure were designed. The strength of concrete shall be determined in accordance with one of the following methods:—

(1) By established results for average materials as provided in section twenty-six hundred and eleven (Average Concrete).

(2) By specific test of materials for the structure as provided in section twenty-six hundred and twelve (Controlled Concrete).

(b) Structural concrete made with artificial aggregates, with special cements, or with admixtures, shall always be made in accordance with method (2) for controlled concrete. (The water-cement ratio strength relation will generally be different than for natural aggregates, normal cement, or usual mixtures.) The commissioner may waive the requirements of this paragraph subject to such conditions as he may specify.

Sect. 2611. Average Concrete.—(a) The following table gives the compressive strength in pounds per square inch which shall be assumed as the basis for design where no preliminary concrete strength tests of the materials to be used are made. A bag of cement weighing ninety-four pounds shall be assumed to measure one cubic foot.

Assumed Strengths of Concrete Mixtures.

Minimum Proportions: Volume of Portland Cement to Sum of Separate Volumes of Fine and Coarse Aggregates, measured Dry and Loose.	Maximum Water-Cement Ratio, United States Gallons per Bag of Cement.[1]	Assumed Compressive Strength at 28 Days (Pounds per Square Inch).
1:7½	8.00	1,500
1:6	7.25	2,000
1:5	6.50	2,500
1:4	6.00	3,000
1:3	5.00	3,750

[1] Including the water content of the aggregate. Unless this content is determined by tests, it shall be assumed to be one half gallon per cubic foot of fine aggregate.

(b) During the progress of the work, such reasonable number of compression tests shall be made as may be required by the commissioner, but at least one set of specimens shall be tested for each three hundred cubic yards of each different mixture of concrete being placed. The tests shall be made in accordance with provisions of section twenty-six hundred and thirteen. If the average twenty-eight-day strength falls below the strength called for on the plans, the commissioner shall have the right to require a load test under the provisions of Part 23. The commissioner may waive the requirement of tests on work involving in all less than two hundred cubic yards of concrete.

(c) Average concrete exposed to the weather shall contain not less than six bags of cement per cubic yard of concrete and the water-cement ratio shall not exceed six gallons per bag of cement.

Sect. 2612. Controlled Concrete.—(a) When the proportions are to be established by tests, the tests shall be made in advance of the beginning of construction using the materials proposed and consistencies suitable for the work and in accordance with the provisions of section twenty-six hundred and thirteen. The relation between the average twenty-eight-day strength of the concrete and the water-cement ratio shall be determined by such tests for a range of values including all of the strengths called for on the plans. The water-cement ratio determined for each quality of concrete to be used shall allow sufficient margin of strength to provide for the exigencies of field operations. In no case, however, shall concrete exposed to the weather contain less than five bags of cement per cubic yard of concrete or have a water-cement ratio in excess of six gallons per bag. No change or substitution shall be made in the materials being used on the work without additional tests to determine the new water-cement ratios to be used.

(b) During the progress of the work, a reasonable number of compression tests may be required by the commissioner, but at least one set of specimens shall be tested for each one hundred and fifty cubic yards of concrete of a given strength, and not less than one set of specimens of each strength of concrete for each day's operation. Such tests shall be made in accordance with the provisions of section twenty-six hundred and thirteen. If the average twenty-eight-day strength of the tested specimens for any portion of the structure falls below the strength called for on the plans, the commissioner shall have the right to require load tests as specified in Part 23 on the portions of the building affected, and to order a change in the mixture for the remaining portion of the structure.

(c) Controlled concrete shall be proportioned, mixed and placed under the supervision of an approved concrete control engineer.

Sect. 2613. Field Tests of Concrete.— (a) Specimens for compression tests of concrete, when required, shall be made and stored in accordance with the Standard Method of Making and Storing Compression Test Specimens of Concrete in the Field, and tested in accordance with the Standard Method of Making Compression Tests of Concrete, of the American Society for Testing Materials; provided, that each set shall consist of at least three specimens which shall be stored under moist curing conditions at seventy degrees Fahrenheit, and no specimens need be stored on the structure.

(b) If tests disclose a consistent relation between the seven-day and the twenty-eight-day strength of the concrete, the tests required during the progress of concrete work may be made at seven days and the strength at twenty-eight days determined therefrom.

Sect. 2614. Concrete Proportions and Consistencies.—(a) The proportions of cement and aggregates for concrete shall be such as to produce concrete that will work readily into the corners and angles of the forms and around the reinforcement without excessive puddling or spading and without permitting the materials to segregate or free water to collect on the surface. The combined aggregate shall be of such composition of sizes that when separated by a number four standard sieve, the weight retained on the sieve shall not be less than one third nor more than two thirds of the total. The consistency of the concrete shall be such that the slump as measured by the slump test shall not exceed the values given in the following table:—

CLASS OF CONCRETE.	Maximum Allowable Slump.
Heavy foundations, massive walls	4 inches
Other reinforced concrete	6 inches

(b) The methods of measuring concrete materials shall be such that the proportion of all ingredients including water can be accurately controlled during the progress of the work and easily checked at any time by the commissioner

Sect. 2615. Mixing Concrete.— Concrete shall be mixed until there is a uniform distribution of the materials and the mass is homogeneous and uniform in color. In machine mixing, only batch mixers shall be used. Each batch shall be mixed not less than one minute after all the materials are in the mixer and must be completely discharged before the mixer is recharged.

Sect. 2616. Concrete Forms and Equipment.— (a) Forms shall be substantial and sufficiently tight to prevent loss of mortar from the concrete.

(b) Before concrete is placed equipment for mixing and transporting the concrete and forms shall be clean; the spaces to be occupied by the concrete shall be free of snow, ice and debris.

Sect. 2617. Removal of Water from Excavations.— Water shall be removed from excavations before concrete is deposited, unless otherwise directed by the commissioner. Water flowing into an excavation shall be diverted through proper side drains to a sump, or be removed by other approved methods which will avoid washing the freshly deposited concrete.

Sect. 2618. Transporting Concrete.— (a) Concrete shall be handled from the mixer to the place of final deposit by methods which will prevent the separation or loss of the ingredients. Under no circumstances shall concrete that is partially hardened be deposited in the work.

(b) Concrete otherwise meeting the requirements of this code but mixed at a distance from the structure in which it is to be deposited may be used provided the time elapsed between addition of the cement to the aggregate and its deposit in the forms does not exceed one hour.

Sect. 2619. Placing Concrete.— (a) Concrete shall not be placed until the forms and reinforcement have been inspected and approved by the inspector required by section twenty-six hundred and three.

(b) When concreting is once started, it shall be carried on as a continuous operation until the placing of the section or panel is completed. The top surface shall be kept generally level and accumulations of water on the surface shall be promptly removed. Where construction joints are necessary, they shall be made in accordance with section twenty-six hundred and twenty-two.

(c) Concrete shall be thoroughly compacted by puddling with suitable tools during the operation of placing, and thoroughly worked around the reinforcement.

Sect. 2620. Depositing Concrete in Cold Weather.—When depositing concrete at freezing or near freezing temperature, the concrete shall be maintained at a temperature of not less than fifty degrees Fahrenheit, and not more than one hundred and twenty degrees. The temperature of the concrete shall be maintained at not less than fifty degrees for at least seventy-two hours after placing. When necessary, concrete materials shall be heated before mixing. Dependence shall not be placed on salt or other chemicals for the prevention of freezing.

Sect. 2621. Curing Concrete.—(a) Exposed surfaces of concrete shall be kept moist for a period of at least seven days after being deposited.

(b) Forms shall be removed in such a manner and with such precautions as to insure complete safety of the structure.

***Sect. 2622. Construction Joints in Concrete.** — (a) Joints not indicated on the plans shall be so made and located as least to impair the strength of the structure. Such joints in floors shall be located near the middle of spans of slabs, beams, or girders, unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. At least two hours must elapse after depositing concrete in columns or walls before depositing in beams, girders, or slabs supported thereon. Beams, girders, brackets, column capitals, and haunches shall be considered part of the floor system and shall be placed monolithically therewith. All joints shall be bonded in accordance with section twenty-six hundred and twenty-three. (For construction joints in flat slabs, see also section twenty-six hundred and sixty-eight.)

(b) Construction joints shall occur within the middle third of the span and preferably where the shear is least. At each such joint, reinforcing steel shall be provided perpendicular to the joint and near the top of the slab and its amount shall be equal to .003 of cross-section area of the concrete. These rods shall be spaced not over two times the thickness of the slab or within the width of the beam or girder. Rods shall be fully anchored each side of the joint.

[**As amended by Ord. 1943, ch. 8 and Ord. 1955, ch. 2.*]

†Sect. 2623. Bonding Fresh and Hardened Concrete. — Before new concrete is deposited on or against concrete which has set, the surface of the set concrete shall be roughened, cleaned of foreign matter and laitance and thoroughly wetted but not saturated. Such surfaces shall first be slushed with a coating of neat cement grout, against which, before it has attained its initial set, the new concrete shall be placed.

[*†As amended by Ord. 1943, ch. 8*]

Sect. 2624. Bending Reinforcement.— Metal reinforcement shall not be bent, straightened or handled in any manner that will injure the material. Reinforcement may be heated only when approved by the commissioner. Cold bends shall be made around a pin having a diameter of not less than four times the diameter of the bar. Bars with kinks or bends not shown on the plans shall not be used.

Sect. 2625. Placing Reinforcement.— (a) Metal reinforcement shall be clean and free of loose mill and rust scale and of other coatings that would destroy or reduce the bond. It shall be accurately placed, supported and secured.

(b) The minimum clear distance between parallel bars shall be one and one half times the diameter for round bars and twice the diameter for square bars. If the ends of bars are anchored as specified in section twenty-six hundred and forty-five, the clear spacing may be made equal to the diameter

of round bars or to one and one half times the diameter of square bars, but in no case shall the spacing between bars be less than one inch, nor less than one and one third times the maximum size of the coarse aggregate. The minimum clear distance between bars and forms shall be the diameter of round bars and one and one half times the diameter of square bars. Bars shall be embedded a distance from the face of a member not less than the distance required for fire and rust protection in this code. The main longitudinal steel of a reinforced concrete slab shall be spaced not more than three times the slab thickness.

Sect. 2626. Splices in Reinforcement.— (a) In slabs, beams and girders, splices of reinforcement shall generally be avoided at points of maximum stress and, where made, shall provide sufficient lap to transfer the stress by bond and shear.

(b) In columns longitudinal reinforcement may be spliced by lapping the bars a length sufficient to develop the working stress in the reinforcement by means of bond, but in no case shall the lap be less than twenty-four bar diameters for deformed bars or thirty diameters for plain bars. Butt joints of approved design are permitted at points where only compressive stress occurs.

Sect. 2627. Protective Covering of Reinforcement.— (a) At the underside of footings and elsewhere in concrete poured in contact with the ground, the main metal reinforcement shall have a minimum covering of three inches except that in floor slabs poured on dry earth such covering may be one and one half inches. In concrete poured in forms but exposed to soil backfill, moisture or weather, such covering shall be two inches.

(b) In buildings of Type I and Type II construction, and in other reinforced concrete required to have specified fire resistance, main metal reinforcement shall be protected as required in sections one hundred and twenty-four to one hundred and thirty-one, inclusive, of Part 1, in Parts 16, 17 and 22, respectively, and elsewhere in this code.

(c) Bars used for the support or spacing of reinforcement, shrinkage reinforcement, column ties and stirrups not over one half inch in diameter, shall not be considered main reinforcement. Such bars shall have minimum protective covering one half inch less than specified in this section for main reinforcement.

Sect. 2628. Pipes and Conduits Embedded in Concrete.— Pipes which will contain liquid, gas or vapor at other than room temperature shall not be embedded in concrete necessary for structural stability or fire protection. Drain pipes and pipes whose contents will be under pressure greater than atmospheric pressure by more than one pound per square inch shall not be embedded in structural concrete except in passing through from one side to the other of a floor, wall or beam. Electric conduits and other pipes embedment of which is allowed shall not, with their fittings, displace that concrete of a column on which stress is calculated or which is required for fire protection, to greater extent than four per cent of the area of cross-section. Sleeves or other pipes passing through floors, walls or beams shall not be of

such size or in such location as unduly to impair the strength of the construction; such sleeves or pipes may be considered as replacing structurally the displaced concrete, provided they are not exposed to rusting or other deterioration, are of galvanized or uncoated iron or steel not thinner than standard wrought iron pipe, have a nominal inside diameter not over two inches, and are spaced not less than three diameters on centers. Embedded pipes or conduits other than those merely passing through shall not be larger in outside diameter than one third the thickness of the slab, wall or beam in which they are embedded, shall not be spaced closer than three diameters on centers, nor so located as unduly to impair the strength of the construction. Circular uncoated or galvanized electric conduit of iron or steel may be considered as replacing the displaced concrete.

*Sect. 2629. **Allowable Unit Stresses in Concrete.** — (a) Reinforced concrete members shall be designed with reference to safe loads and working stresses. The unit stresses in pounds per square inch in concrete of the strength indicated shall not exceed the following allowable values, where (f'_c) is the strength at twenty-eight days:—

Kind of Stress.	Allowable Unit Stresses.			
	Expressed as a Proportion of the Strength.	Specific Values for Common Strengths (Pounds per Square Inch). Strength.		
		2,000.	2,500.	3,000.
Flexure:		$n = 15$	$n = 12$	$n = 10$
Extreme fiber stress in compression	$0.40\ f'_c$	800	1,000	1,200
Shear:				
Beams with no web reinforcement and without special anchorage of longitudinal steel	$0.02\ f'_c$	40	50	60
Beams with no web reinforcement, but with special anchorage of longitudinal steel	$0.03\ f'_c$	60	75	90
Beams with web reinforcement, but without special anchorage of longitudinal steel	$0.06\ f'_c$	120	150	180
Beams with web reinforcement and with special anchorage of longitudinal steel	$0.09\ f'_c$	180	225	270
Flat slabs at distance (d) from edge of column cap or drop panel (see also section 2641)	$0.025\ f'_c$	50	62	75
Footings (see also section 2642)	$0.02\ f'_c$	40	50	60
Bond:				
Plain bars not to exceed 160 # □″	$0.04\ f'_c$	80	100	120
Deformed bars not to exceed 200 # □″	$0.05\ f'_c$	100	125	150
Bearing:				
On full area	$0.25\ f'_c$	500	625	750
On one third or less area, axially applied	$0.375\ f'_c$	750	937	1,125
Axial Compression:				
In columns with lateral ties	$0.18\ f'_c$	360	450	540
In columns with continuous spirals enclosing a circular core	$0.225\ f'_c$	450	562	675

(b) The bond stress computed in accordance with section twenty-six hundred and forty-three may be allowed to reach double these values where special anchorage is provided as specified in section twenty-six hundred and forty-five.

(c) The allowed bearing stress on an area greater than one third but less than the full area shall be interpolated between the values given in the table.

(d) The ratio of the moduli of elasticity of steel and concrete shall be assumed as (n) = $\frac{30,000.}{f'_c}$

[**As amended by Ord. 1943, ch. 8*]

†**Sect. 2630. Allowable Unit Stresses in Steel.** — (a) The following allowable unit stresses shall not be exceeded in reinforcing steel.

Allowable Unit Stress (Pounds per Square Inch).

Tension:	
Structural grade billet steel bars	18,000
Rerolled steel bars	18,000
Intermediate grade billet steel bars	20,000
Cold drawn steel wire or cold stretched expanded metal fabric	20,000
Rerolled rail steel reinforcing bars	20,000
Web reinforcement (steel)	16,000
Other steel reinforcement fifty per cent of the yield point, but not to exceed	18,000

(b) Compression in reinforcing steel except in columns, shall not exceed (n) times the compressive stress in the concrete at a line in the cross-section through the center of the bars.

(c) Compression in structural steel and cast iron in composite and combination columns shall not exceed the stress specified in sections twenty-six hundred and seventy-five and twenty-six hundred and seventy-six.

(d) The modulus of elasticity shall be assumed as thirty million pounds per square inch.

[†*As amended by Ord. 1943, ch. 8 and Ord. 1949, ch. 8*]

Sect. 2631. Design of Reinforced Concrete for Wind Loads.—In designing the members of reinforced concrete structures to resist wind loads, the allowable unit stresses for dead and live load and wind loads may be increased to four thirds of the allowable values specified in sections twenty-six hundred and twenty-nine and twenty-six hundred and thirty, but no member shall be less than that required if the wind load be neglected.

Sect. 2632. Design of Reinforced Concrete in Flexure.—(a) The accepted theory of flexure as applied to reinforced concrete shall be applied to all members resisting bending. The following assumptions shall be made:—

(1) The steel alone resists tensile stress and acts only in the direction of its length.

(2) The ratio (n) of the modulus of elasticity of the steel either in tension or compression to that of any given concrete is constant.

(3) Plane sections before bending remain plane after bending.

(b) Beams and slabs shall be designed to resist safely the actual bending and shear produced by the loads and supporting forces under the existing conditions of end restraint or continuity. It is the intent of this part to require that the bending moments throughout the spans be determined so far as possible consistently with the elastic deformation of the structure, being in general calculated according to the provisions of section twenty-six hundred and thirty-five by methods of elastic analysis; but they may in the special cases and with the limitations described in section twenty-six hundred and thirty-six be approximated by the use of arbitrary moment coefficients as provided therein. Wherever negative bending may occur, the full amount thereof shall be provided for, except in slabs thirty inches or less in span.

Sect. 2633. Span Length of Reinforced Concrete Members.—(a) The span length of freely supported beams and slabs shall be the distance between centers of bearings, but need not exceed the clear span plus the depth of beam or slab.

(b) The span length for continuous or restrained beams and slabs built to act integrally with supports shall be the clear distance between faces of supports, the spaces occupied by supports where restraint or continuity occurs being suppressed in the force and moment diagrams.

(c) For continuous beams having brackets built to act integrally with both beam and support and of a width not less than the width of the beam and making an angle of forty-five degrees or more with the beam, the span shall be measured from the section where the combined depth of the beam and bracket is at least one third more than the depth of the beam. Brackets making an angle of less than forty-five degrees with the beam may be considered as increasing the effective depth of the beam, but not as decreasing the span length. Beams shall be designed to resist at each section the bending there occurring.

(d) Maximum negative moments are to be considered as existing at the ends of the span, as defined above.

***Sect. 2634. Depth of Reinforced Concrete Beam and Slabs.**—(a) The effective depth of beams and slabs shall be taken as the distance from the center of gravity of the tensile reinforcement to the compressive surface of the structural member; except for monolithic beams and slabs where the top is a wearing surface, then the effective depth shall be taken to a plane one-half inch below the finished surface.

(b) For beam and slab construction the total thickness for slabs shall not be less than three and one-half inches except as provided in sections twenty-six hundred fifty-three and twenty-six hundred fifty-nine.

[**As amended by Ord. 1943, ch. 8*]

Sect. 2635. Analysis of Bending in Reinforced Concrete.—(a) The determination of bending moments to be provided for at various points in the span of a member restrained at supports, or a series of continuous spans, in accordance with section twenty-six hundred and thirty-two, shall be made by application of the theorem of three moments, principle of least work, or equivalent method based on elastic deformation, and shall be subject to the following qualifications:—

(1) Supports afforded by beams, girders and columns of usual arrangement shall be assumed to be and remain in alignment conforming to the position of the unloaded beam or slab.

(2) The effect on bending moments in the spans produced by the torsional resistance of interior supporting beams and by the bending resistance of ordinary interior supporting columns may be neglected, and shall be neglected unless the restraint is computed and provided for in the supports. Restraint at exterior supports shall be provided for both in the spans and in the supports.

(3) The difference in moment of inertia of beams of approximately the same depth in different spans and of the same beam acting to resist positive and negative bending, may be considered negligible so far as regards its effect on distribution of moment throughout the spans. The moment of inertia may be calculated from the gross section of the concrete neglecting reinforcement and the flanges of T-beams may be neglected.

(4) Design for bending, both positive and negative, that may occur within a span shall include consideration of the effects of a partial distribution of load on the span itself and either or both adjacent spans, but not on spans more remote than these. Maximum negative moment at a support may be assumed to result from full loading on adjacent spans only.

(b) The commissioner may approve analyses conforming to the intent of this part, based on accepted theory, and incorporating refinements other than these provided herein; and he may require special analysis for extraordinary conditions of support, restraint, span lengths and distribution of load.

Sect. 2636. Arbitrary Moment Coefficients for Reinforced Concrete.— (a) In the case of a beam or a slab, or a series of continuous beams or slabs with spans differing not more than twenty-five per cent of the longer span, uniformly loaded, and falling within one of the specified cases of restraint at the supports, designs may be made to resist bending moments computed by the arbitrary coefficients presented in this section, instead of by elastic analysis.

(b) The coefficients of (wL^2) set forth in the following table may be used to compute the positive bending at mid-span and the negative bending at supports in the locations and under the conditions indicated.

Table of Arbitrary Coefficients for Bending.

Conditions of Restraint.	Number of Spans.	End Span.		First Interior Support.	Interior Spans.	
		End Support.	Mid-Span.		Mid-Span.	Other Interior Supports.
Case 1: Slabs or beams with negligible restraint at end supports.	1	1/24	1/8	—	—	—
	2	1/24	1/10	1/8	—	—
	Mult.	1/24	1/12	1/9[1]	1/16	1/12
Case 2: Slabs or beams with moderate restraint at end supports.	1	1/16	1/10	—	—	—
	2	1/16	1/12	1/9	—	—
	Mult.	1/16	1/14	1/10	1/16	1/12
Case 3: Slabs or beams with full restraint at end supports.	1	1/12	1/12	—	—	—
	2	1/12	1/16	1/10	—	—
	Mult.	1/12	1/16	1/11	1/16	1/12

[1] One tenth for slabs.

(c) In the use of this table negligible restraint shall be assumed for slabs supported on walls of masonry units, or on the upper flanges of steel beams not encased in concrete; and for beams supported on steel or cast iron columns not encased in concrete, or on combination columns, or on masonry piers or walls of any type other than reinforced concrete columns acting integrally therewith, or by other beams or girders; or on any supports which do not assure as great restraint as that described as "moderate."

(d) Moderate restraint may be assumed for slabs supported by reinforced concrete beams, or by steel beams encased in concrete, or by reinforced concrete walls; and for beams or girders supported on composite columns or on reinforced concrete columns, provided the slabs or beams act integrally with the support.

(e) Full restraint may be assumed only for slabs acting integrally with supporting reinforced concrete walls and for beams or girders acting integrally with reinforced concrete columns, when (I/L) for the slab, beam or girder is less than the sum of the values of (I/h) for the walls or columns, respectively, above and below. In this section (I) represents the moment of inertia, calculated for the gross section of the concrete, neglecting reinforcement and the flanges of T-beams. (L) and (h) are span length and column or wall height, respectively.

(f) In calculating negative bending at a support between two spans of unequal load or length, the average unit load over the two spans shall be used, and an assumed span which is two thirds the longer span plus one third the shorter span.

(g) For continuous or restrained beams or girders subject to equal concentrated loads which occur at approximately regular intervals with a concentration at each support, the positive and negative bending may be determined as though the entire load were distributed uniformly on the beam or girder.

***Sect. 2637. Points of Inflection in Reinforced Concrete, and Shear.** — The location of points of inflection, reactions and shears, shall be assumed consistently with the loading and the computed distribution of bending moments. In the three cases of slabs and beams of two or more continuous spans when the arbitrary coefficients for bending of section twenty-six hundred and thirty-six may be applied, the reactions on end supports shall be taken as forty per cent for Case 1, forty-five per cent for Case 2, and fifty per cent for Case 3, of the load on the end span, and the reaction on the first interior support shall be computed accordingly; the loads on interior spans may be assumed as evenly divided between supports in determining shears and reactions.

[**As amended by Ord. 1943, ch. 8*]

Sect. 2638. Diagonal Tension in Reinforced Concrete Beams.— (a) Reinforced concrete beams (including ribs of ribbed and combination slabs, and other members subject to bending) shall be designed to resist the diagonal tension in their webs without exceeding the stresses prescribed in sections twenty-six hundred and twenty-nine and twenty-six hundred and thirty.

(b) For the purpose of design, the diagonal tension in the web of a beam shall be assumed to be directed at an angle of forty-five degrees with the axis of the beam, and its intensity to be equal to the unit shear, computed by the formula:

$$v = \frac{V}{b'jd}$$

In this formula (b′) is to be taken as the width of the concrete section between the tensile steel and the compressive flange, the average width if the sides slope but not over twenty per cent more than the minimum.

(c) Beams in which the diagonal tension in any portion of the web exceeds the stress allowed in beams without web reinforcement shall be reinforced in that portion for the excess.

Sect. 2639. Types of Web Reinforcement.— (a) Web reinforcement shall consist of vertical stirrups or of stirrups or bars inclined at an angle of not less than fifteen degrees with the axis of the beam.

(b) Web reinforcement shall be considered effective only to the extent that its stress can be developed by bond and anchorage as provided in section twenty-six hundred and forty-six.

Sect. 2640. Design of Web Reinforcement.— (a) A web reinforcing bar, whether vertical or inclined, shall be considered to afford for resistance to diagonal tension the component of its tensile stress in the direction of the diagonal tension. The spacing of stirrups (or the length of beam over which the resistance of a stirrup or bar is effective) is therefore determined by the following formula:

$$s = \frac{A_v\, f_v\, jd\, (\cos a + \sin a)}{V'}$$

For vertical stirrups this becomes —

$$s = \frac{A_v\, f_v\, jd}{V'}$$

and for stirrups or bars inclined at forty-five degrees —

$$s = \frac{A_v\, f_v\, jd}{0.7\, V'}$$

(b) In the formulas of this section (V′) is the shear in the beam at any cross-section in excess of the allowed resistance of the unreinforced web, and it shall be subject to the limitation imposed upon the unit shear by section twenty-six hundred and twenty-nine. The spacing (s) of stirrups, vertical or inclined, or of bars inclined at not less than forty-five degrees shall not exceed three fourths the effective depth of the beam. In the case of bars inclined at less than forty-five degrees, (s) shall not exceed three fourths the axial projection of the inclined length.

(c) In portions of beams where the unit shear exceeds ($0.06\ f'_c$) the limits for (s) shall be reduced by changing the fraction three-fourths to one-half in the preceding paragraph.

Sect. 2641. Shearing Stress in Concrete Flat Slabs.— (a) In flat slabs, the shearing unit stress on a vertical section which lies at a distance (d) from the edge of the column capital and parallel with it, shall not exceed the following allowable values when computed by the formula given in section twenty-six hundred and thirty-eight for shearing unit stress in beams.

(1) $0.03\ f'_c$ — when at least fifty per cent of the total negative reinforcement in each column strip passes directly over the column capital.

(2) $0.025\ f'_c$ — when twenty-five per cent of the total negative reinforcement in each column strip passes directly over the column capital (which is the least that shall be permitted).

(3) For intermediate percentages, proportionate intermediate values of the allowable shearing unit stress shall be used.

(b) In flat slabs, the shearing unit stress on a vertical section which lies at a distance (d) from the edge of the dropped panel and parallel with it shall not exceed ($0.03\ f'_c$).

(c) For the purposes of this section (d) shall be the average depth at the section in question from the compressive surface of the concrete to the center of the tensile reinforcement for negative bending.

Sect. 2642. Shear and Diagonal Tension in Footings. —(a) The shearing unit stress computed by the formula given in section twenty-six hundred and thirty-eight on any vertical peripheral or plane section of a footing at a distance (d) from the face of the supported column or pier and parallel with it, shall not exceed ($0.02\ f'_c$) for footings with straight bars, nor ($0.03\ f'_c$) for footings in which the bars have special anchorage as specified in section twenty-six hundred and forty-five.

(b) In footings supported on piles, the critical section for diagonal tension shall be considered at a distance (d/2) from the face of the supported column or pedestal and any piles whose centers are at this section or nearer the supported column or pedestal shall be excluded in computing the shear.

Sect. 2643. Bond Stress in Reinforced Concrete.— (a) Members subject to bending shall be so proportioned that the increments of stress in the tensile steel are transmitted to it from the concrete in which it is embedded, without producing bond stress exceeding that specified in section twenty-six hundred and twenty-nine.

(b) In beams in which the tensile reinforcement is parallel to the compressive face, and is not specially anchored, the bond stress (u) shall be assumed to be determined by the following formula:—

$$u = \frac{V}{g\ jd}$$

(c) In non-prismatic or wedge-shaped beams, as represented by a cantilever bracket, a sloped top footing, or a beam with cambered compressive face, in which the depth of the beam is increased in the direction of increasing

bending moment, the bond stress is not proportional to the shear, being at all sections smaller than indicated by the formula of paragraph (b) for a prismatic beam of depth equal to the depth at the section considered. For such beams the bond stress shall be assumed to be determined by the following formula:—

$$u = \frac{V}{g\,jd} \times \left(1 - m\frac{M}{Vd}\right)$$

in which (m) is the tangent of the angle between the compressive face and the tensile re-inforcement.

(d) Adequate end anchorage of bars in prismatic beams which are subject to excessive bond stress, as computed by the formula of paragraph (b), may result in the relief of such excessive bond stress, by inducing in the beam an arch action, with distribution of bending stresses analogous to that in a cambered beam. About bars so anchored the computed bond stress may be double that allowed for unanchored reinforcement.

(e) Special anchorage adequate to justify increased bond stress shall be capable of developing the maximum tension in the bars in excess of that developed by bond at its allowable value. The excess tension (T′) shall be determined by the formula:—

$$T' = T\left(1 - \frac{u'}{u}\right)$$

in which (T) is the maximum tensile stress.

(u′) is the allowable stress in bond for unanchored reinforcement.

(u) is the maximum bond stress computed by one of the formulas of paragraphs (b) and (c).

(f) In simply supported beams the required special anchorage shall be provided beyond the face of the support. In continuous beams sufficient special anchorage of the positive reinforcement beyond the point of inflection may be considered to be provided by the extension of such bars to the ends of the span. For the negative reinforcement of restrained or continuous beams, and for the tensile reinforcement of cantilevers, brackets and footings, the required special anchorage shall be provided by extending or hooking the bars beyond the point at which tension begins.

(g) In applying the formulas of paragraphs (b) and (c) to any section of a beam in which the tensile reinforcement is varied by bending or discontinuing a portion of the bars, there shall be counted as contributing their perimeters to bond resistance only those bars at that section and in the plane of the main longitudinal tensile steel, in which tensile stress is increasing consistently with the assumptions under which the beam is designed.

Sect. 2644. **Ordinary Anchorage of Reinforcement.**—(a) Reinforcement acting in tension at a restrained end of a beam or in a cantilever shall have anchorage on both sides of the face of the support and beyond the point where any portion of the reinforcement is discontinued sufficient to develop the tension in each of the bars.

(b) In a restrained beam at least one third of the tensile reinforcement for negative bending shall be extended at least to the point of inflection of the beam.

(c) At least one fourth of the tensile reinforcement for positive bending in a beam shall be extended at least to the end of the span. Bars not so extended may be bent across the web, becoming continuous with the negative reinforcement, or otherwise anchored in a region of compression.

Sect. 2645. Special Anchorage of Reinforcement.—(a) Where, by reasons of special anchorage of reinforcement, increased shearing stresses are allowed, reinforcement in the proportions specified in section twenty-six hundred and forty-four shall be extended in beams as there specified, and anchorage shall further be provided beyond the points of inflection for the negative reinforcement of restrained beams, and beyond the end of the span for positive reinforcement of freely supported beams, sufficient to develop at least one half of their allowable tensile stress. In footings, special anchorage justifying increased shearing stress shall be considered as provided when all bars are anchored by means of hooks at their ends. The outer face of hooks shall be as close to the face of the footing as the requirements for rust protection will allow.

(b) Where anchorage is furnished by extension of the bars, such extension may be assumed to provide an anchorage capacity equal to the embedded surface multiplied by the allowable unit bond resistance specified in section twenty-six hundred and twenty-nine. A hook, for the purpose of this section, means a complete semicircular hook as defined in section twenty-six hundred and two. Such a hook may be assumed to develop a stress of not more than ten thousand pounds per square inch in the bar so anchored. A bend of larger radius than allowed in a hook shall be considered as a mere extension of the bar.

Sect. 2646. Anchorage of Web Reinforcement.—(a) The stress in a stirrup or web reinforcement bar for resistance of diagonal tension in a beam shall not exceed the capacity of its anchorage in the upper or lower one half of the effective depth of the beam nor the allowable stress specified in section twenty-six hundred and thirty.

(b) Web reinforcement which is provided by bending into an inclined position one or more bars of the main tensile reinforcement where not required for resistance to positive or negative bending shall be considered completely anchored by continuity with the main tensile reinforcement or by embedment of requisite length in the upper or lower half of the beam, provided at least one half of such embedment is as close to the upper or lower surface of the beam as the requirements of fire or rust protection allow. A hook placed close to the upper or lower surface of the beam may be substituted for a portion of such embedment.

(c) Stirrups shall be anchored at both ends by one of the following methods or by a combination thereof:—

(1) Rigid attachment, as by welding, to the main longitudinal reinforcement. The capacity of this anchorage is limited to that of the attachment.

(2) Bending around and closely in contact with a bar of the main longitudinal reinforcement in the form of a U-stirrup or a hook. The capacity of this anchorage may be taken as sixteen thousand pounds per square inch in the stirrup.

(3) A hook placed as close to the upper or lower surface of the beam as the requirement for fire and rust protection will allow. The capacity of this anchorage shall be ten thousand pounds per square inch in the stirrup plus the stress developed by bond between mid-height of the effective depth of the beam and the beginning of bending of the hook.

(4) A length of embedment in the upper or lower half of the effective depth of the beam, whether straight or curved. The capacity of this anchorage shall be limited to the stress developed by bond on the embedded length. Anchorage of this type shall not be used on stirrups where the unit shear exceeds ($0.06\ f'_c$).

Sect. 2647. Slenderness of Reinforced Concrete Beams.—The clear distance between lateral supports of a beam shall not exceed thirty-two times the width of the compression area of the cross-section.

Sect. 2648. T-Beams of Reinforced Concrete.— (a) In T-beam construction the slab shall be built integrally with the beam. In the design of symmetrical T-beams the overhanging flange width on either side of the web shall not exceed one tenth the span, nor eight times the thickness of the slab nor one half the clear distance to the next beam.

(b) For beams having a flange on one side only, the effective overhanging flange width shall not exceed one twelfth of the span length nor six times the thickness of the slab nor one half the clear distance to the next beam.

(c) Where the principal reinforcement in a slab which serves as the flange of a T-beam (not a rib in ribbed floors) is parallel to the beam, transverse reinforcement shall be provided in the top of the flange. The spacing of the bars shall not exceed five times the thickness of the flange, or eighteen inches.

(d) Isolated beams in which the T-form is used only for the purpose of providing additional compression area, shall have a flange thickness not less than one half, and a total flange width not more than four times, the web thickness.

Sect. 2649. Compression Reinforcement in Beams and Girders.— Steel reinforcing bars in compression in girders and beams shall be thoroughly anchored against buckling by ties or stirrups not less than one quarter inch in diameter spaced not further apart in the region where compression steel is required than twelve times the diameter of the bars, or by equivalent lateral support.

***Sect. 2650. Structural Steel Beams Encased in Concrete.**— (a) Structural steel beams which are fireproofed by being wholly encased in the concrete of a reinforced concrete floor or roof may be designed for bending as composite beams, the two materials assumed to act elastically together, the concrete not to act in tension, the stresses in the respective materials not to exceed those allowed by this code.

(b) Any steel beam or girder completely encased in concrete as described in paragraph (a) having a compressive strength of at least two thousand pounds per square inch and comprising an integral part of a complete floor system such as concrete slabs and beams, in conformity with section twenty-six hundred and forty-eight, may have its resistance to bending increased fifteen per cent.

(c) Stresses allowed in paragraph (b) shall be allowed in tension members of trusses, if the requirements of this section are fulfilled.

[**As amended by Ord. 1943, ch. 8*]

Sect. 2651. Shrinkage and Temperature Reinforcement.— (a) Reinforcement for shrinkage and temperature stresses shall be provided in floor and roof slabs perpendicular to the reinforcement for bending where this runs in one direction only. Such reinforcement shall have an area of cross-section not less than two one thousandths times the area of the concrete and bars shall be spaced not more than five times the slab thickness nor more than eighteen inches.

(b) In reinforced concrete spandrel beams and parapet walls shrinkage reinforcement shall be provided, in amount not less than one half of one per cent, in addition to the reinforcement for bending. Such reinforcement shall be continuous and rods shall be spliced by lapping or otherwise, except at expansion joints.

(c) Consideration shall be given to the stresses due to expansion and shrinkage in buildings more than two hundred feet long and provision shall be made satisfactory to the commissioner for avoiding excessive stress. In buildings longer than four hundred feet expansion joints shall be provided not more than three hundred feet apart. Such joints shall be constructed with at least one inch opening and shall allow for expansion of each section of building not less than one half inch for every one hundred feet of its length.

Sect. 2652. Concentrated Loads on Concrete Slabs.—(a) For computation of stresses due to bending and shear, concentrated loads on one-way slabs may be considered as evenly distributed over an effective width at right angles to the direction of the span as follows: —

Solid concrete construction . . .	w + 0.8 s
Combination floor construction . .	w + 0.6 s
Ribbed floor construction . . .	w + 0.4 s but not more than w + twice the rib spacing

where (w) is the actual width of the concentration and (s) is the distance from the nearer support to the center of the concentration. For concentrations at mid-span or for loads such as partitions which are concentrated laterally but distributed longitudinally to the span, (s) shall be taken as equal to half the span.

(b) If adequate bridging is provided to distribute concentrations among adjacent ribs, the effective width for combination and ribbed slabs may be

taken as for solid slabs, but in the case of ribbed slabs, unless the bridging has approximately the same spacing as the ribs, not more than three adjacent ribs shall be assumed to share the load.

*Sect. 2653. **Concrete Ribbed and Combination Slabs.** — (a) Ribbed floor construction consists of concrete ribs, running in one or two directions and topping placed monolithically with the ribs, not over twenty inches apart between faces. The ribs shall be straight and of a width not less than four inches nor less than one third the depth. The topping shall be of sufficient strength to transmit loads coming upon it to the adjacent ribs and shall be not less than two inches thick. Ribbed slabs shall be reinforced at right angles to the ribs with a minimum of forty-nine one thousandths square inch of reinforcing steel per foot and in slabs on which the prescribed live load does not exceed fifty pounds per square foot, no additional reinforcement shall be required.

(b) Combination floor construction consists of concrete ribs running in one or two directions, with masonry fillers, filling the entire space between ribs, and either with or without a monolithic concrete topping over the ribs. Each masonry filler shall have contact with ribs on two opposite sides. Ribs shall be not over twenty inches apart between faces, shall be straight and of a width not less than four inches nor less than one third the depth. Either the fillers or the topping over them, or the combination of the two shall be of sufficient strength to transmit any load coming on them to the adjacent ribs. If a monolithic topping is used, it shall be not less than one inch thick.

(c) If structural fillers as specified in paragraph (e) are used, then, and not otherwise, certain portions of them may be included with the concrete in calculations of resistance to shear and bending, but the amount included shall nowhere exceed the actual thickness of the portion of the filler nor one and one half inches. In one-way construction the webs of structural fillers which are in contact with the concrete ribs and where there is a topping the web in contact therewith may be included with the concrete in calculations of resistance to shear and bending. In construction in which the ribs run in both directions and at approximately the same distance on centers, and whether designed as one-way or two-way slabs, the webs in contact with the concrete ribs may be included in calculations of resistance to shear and bending and the top and bottom webs may be included in calculations of resistance to bending.

(d) The maximum stress in both the concrete and the filler shall not exceed that allowed in the weaker of the two materials.

(e) A structural filler, for the purpose of this section, shall have an ultimate strength in compression, on its net section, when tested on end at the age of twenty-eight days, of two thousand pounds per square inch. If structural clay tiles are used as fillers they shall at least equal those classified as Grade B in Part 24 of this code. Gypsum tile shall not be used as a structural filler.

(f) The unit extreme compressive fibre stress in the filler tile shall not exceed four tenths of its ultimate unit compressive strength, determined for the net section from an average of three fillers tested on end at an age of

twenty-eight days. The unit stress allowed in shear computations shall not exceed one quarter of the average ultimate strength in shear of the joint between the ribs and the filler blocks.

(g) Where the topping contains conduits or pipes, the thickness shall not be less than one inch plus the total overall depth of such conduits or pipes at any point. Such conduits or pipes shall be so located as not to impair the strength of the construction.

(h) Shrinkage reinforcement shall be provided in the slab as required in section twenty-six hundred and fifty-one.

(i) Neither paper, wood, nor roofing material shall be used between or at the ends of structural hollow masonry fillers included in calculations of resistance to shear or bending to prevent concrete from flowing into the interstices thereof, nor any other material that would impair the bond between the end of the filler and the concrete, but this shall not prevent the use of such materials when inserted in but not projecting from the openings of the fillers nor the use of the same material that is permitted for the fillers themselves. If concrete is allowed to penetrate the interstices of hollow masonry fillers, the weight thereof shall be included in the dead load to be supported. The webs of structural filler units whose ends are thus in contact with the concrete may be included in calculations of resistance to bending.

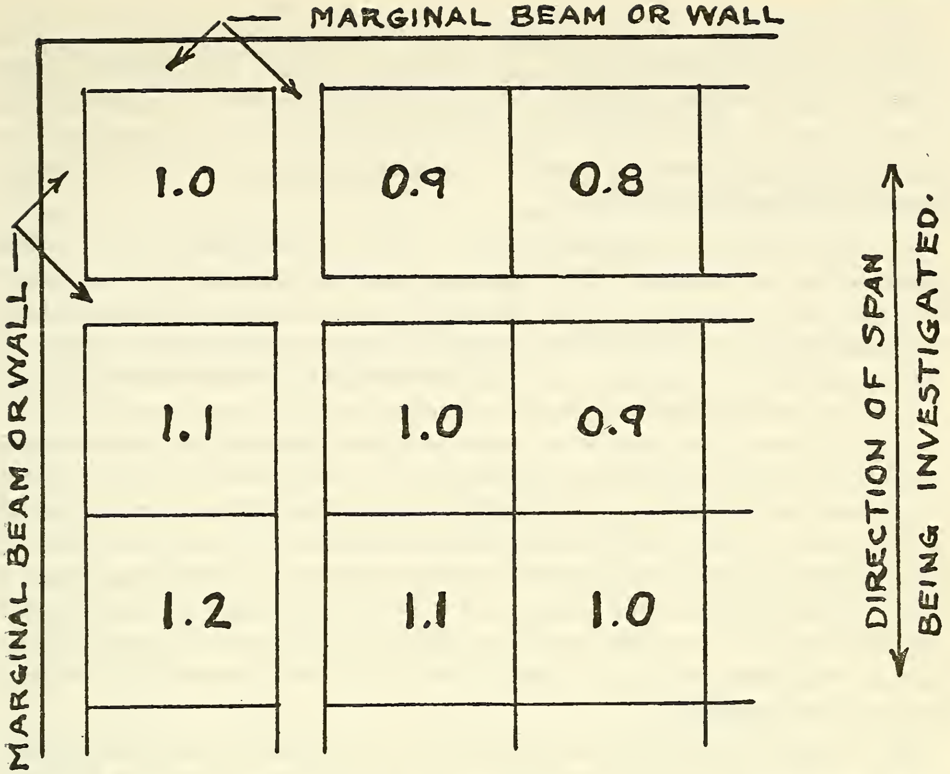
[**As amended by Ord. 1943, ch. 8*]

†**Sect. 2654. Two-Way Slabs of Reinforced Concrete.** — (a) Concrete slabs, either solid, ribbed or combination slabs, supported on four sides by beams, girders or walls, and reinforced to span in two directions shall be designed in accordance with the provisions of this section.

(b) The slab shall be regarded as consisting of a series of adjacent strips of unit width spanning in each direction. In computations for shear and diagonal tension, bond, and for the loading of supporting members, each strip, spanning in either the longer or the shorter direction, shall be assumed to carry and transmit to its supports a total load (W), represented by the expression:

$$W = 1/2\, C_o r\, w\, L = 1/2\, C_o w\, L_1$$

in which (w) is the total load per unit area of the slab.
(L) is the span of the strip.
(L_1) is the width of the panel transverse to the span.
(r) is the ratio of L_1 to L.
(C_o) is a coefficient dependent on the position of the panel relative to adjacent panels continuous with it at its ends and sides, as indicated on the accompanying diagram. Full restraint at end support, as defined in section twenty-six hundred and thirty-six, shall be considered equivalent to continuity in determining (C_o).



VALUES OF C_0 IN VARIOUS PANELS.

(c) The positive bending moment for a strip of unit width in the middle half of the panel, spanning in either direction, shall be assumed as given by the following formula:—

$$M = 0.33\ C_1C_0r^2wL^2 = 0.33\ C_1C_0wL_1^2$$

in which (C_1) is a coefficient for bending determined in accordance with the conditions of restraint at end supports of the strips as provided in section twenty-six hundred and thirty-five or section twenty-six hundred and thirty-six.

(d) Negative moments at and adjacent to supports between two panels shall be determined by the formula given in paragraph (c) for positive moment taking (C_1) as the coefficient for negative moment determined according to section twenty-six hundred and thirty-five or section twenty-six hundred and thirty-six, and in case the conditions of continuity in the two panels are different, taking the mean value of (C_0).

(e) The positive bending in strips of unit width in the outer quarters of the panel may be assumed to be three quarters that of the strips of the middle half

(f) Lines of inflection in a two-way panel shall be assumed at a distance of one fourth of its shorter span from supports over which the slab is continuous.

[†*As amended by Ord. 1943, ch. 8*]

‡**Sect. 2655. Limitations upon Reinforced Concrete Flat Slabs.**— (a) The term "flat slabs" as used herein refers to concrete slabs with reinforcing bars in two or more directions, whose interior supports are columns or the like, generally without beams.

(b) The methods of stress computation herein specified apply to a series of slabs of approximately uniform size extending at least three panels in each direction and in which the length of panel does not exceed one and one half times its width. Flat slabs of other arrangement shall be proportioned to have at least equal carrying capacity and degree of safety according to established principles of mechanics.

(c) Flat slabs with paneled ceiling or with dropped panels may be proportioned by the methods herein specified provided the dropped panel shall have a length or diameter in each rectangular direction not less than one third the panel length in that direction, and the thickness of the thicker portion of the slab shall not exceed one and one half times that of the remainder. In the ceilings of flat slabs, concrete between rods in tensile regions and in compressive regions where it can be spared may be displaced by permanent or removable fillers, provided allowable stresses are not exceeded in the concrete which remains and provided the tensile stress in the reinforcing rods in that region shall not exceed eight ninths the stress allowed in the reinforcement of solid concrete slabs. Compression concrete above such fillers shall have a thickness not less than two inches, and the construction shall safely support any concentration of load that may come upon it. The term "slab thickness" used in connection with such construction shall refer to the total thickness of the structural concrete.

(d) Column capitals, if of concrete, shall be of the mixture required for the column up to a level where the area of a horizontal section is fifty per cent more than the gross area of the shaft of the column. In dimensioning the concrete capital for design purposes, no portion of the capital shall be considered which lies outside the largest ninety-degree circular cone contained within its outlines. The diameter of the capital shall be measured for design purposes at the junction of the cone with the bottom of the slab or dropped panel.

(e) Column capitals of structural metal may be substituted for concrete capitals, whether contained within the thickness of the slab and dropped panel, or not, provided they meet the following requirements:—

(1) they shall have the same protection against fire required for reinforcement in similar exposures;

(2) they shall safely support the slab on the periphery of the capital without exceeding stresses allowed in this code for the kind of metal used;

(3) they shall provide support for the slab or dropped panel at a distance above the bottom thereof not substantially greater than the requirements for fire protection, and such support shall either be continuous along the periphery of the capital or with intervals not greater than three times the thickness of concrete slab, or slab and dropped panel;

(4) the capitals shall be so designed and arranged as to permit the proper placement of concrete in and about them without pockets or voids, and to provide for the transmission of load from columns above to columns below;

(5) the diameter of a structural metal column capital, for purposes of slab design, shall be taken as twice the distance from the center of the column to the center of bearing of slab or dropped panel on a continuous

circumferential support, or twice the average distance to centers of bearing on radial or non-continuous supports, the unit bearing assumed as uniform and not in excess of the stress allowed by this code.

[‡*As amended by Ord. 1943, ch. 8*]

Sect. 2656. Assumptions in Concrete Flat Slab Design.—(a) A flat slab panel shall be considered as consisting of strips, parallel to sides of the panel, as follows:—

(1) A middle strip one half panel in width, symmetrical with respect to the panel center line.

(2) A column strip one half panel in width made up of two quarter-panel areas outside the middle strips.

(3) The strips shall be considered in each rectangular direction for the computation of bending moments.

(b) The critical sections for bending are referred to as the principal design sections and are located as follows:—

(1) Sections for negative bending shall be taken along the edges of the panel at ends of the strips, on center lines of columns, and around the periphery of the column capital.

(2) Sections for positive bending shall be taken at mid-length of the strips, on the center line of the panel.

***Sect. 2657. Bending in Interior Flat Slab Panels.** — (a) The numerical sum of the positive and negative bending moments in either rectangular direction of an interior panel, for the design of tensile reinforcement, shall be assumed as not less than —

$$M_o = 0.09\,WL\left(1 - \frac{2c}{3L}\right)^2 = M_{pc} + M_{pm} + M_{nc} + M_{nm}$$

where (M_{pc}) is the positive moment at mid-span of the column strip.
(M_{pm}) is the positive moment at mid-span of the middle strip.
(M_{nm}) is the negative moment at one end of a middle strip.
(M_{nc}) is the negative moment at one end of the column strip.
(L) is the length of the strips between center lines of columns.
(c) is the diameter of the column capital, or top of column if there is no capital.
(W) is the total live and dead load uniformly distributed over a single panel area.

(b) The bending moments for the design of tensile reinforcement in the principal design sections shall be assumed to be those given in the following table, except that (M_{nc}) may be ($0.03\ M_o$) greater or smaller, and each of (M_{pc}), (M_{pm}) and (M_{nm}) may be ($0.01\ M_o$) greater or smaller provided that the sum remains not less than the value specified for (M_o).

(c) If a flat slab is supported at interior column points by supports less rigid than the columns specified in section twenty-six hundred and sixty-nine, paragraph (b), the positive bending in column and middle strips shall be increased twenty per cent above the tabular values.

Bending Moments in Flat Slabs for Tensile Reinforcement — Interior Panels Fully Continuous.

Moment.	Two-way Reinforcement.		Four-way Reinforcement.	
	Without Dropped Panel.	With Dropped Panel.	Without Dropped Panel.	With Dropped Panel.
M_{pc}	$0.22M_o$	$0.20M_o$	$0.20M_o$	$0.19M_o$
M_{pm}	$0.16M_o$	$0.15M_o$	$0.20M_o$	$0.19M_o$
M_{nc}	$0.46M_o$	$0.50M_o$	$0.50M_o$	$0.54M_o$
M_{nm}	$0.16M_o$	$0.15M_o$	$0.10M_o$	$0.08M_o$

[**As amended by Ord. 1943, ch. 8*]

Sect. 2658. Spacing of Flat Slab Reinforcement.— (a) Bands of rods in two-way systems of reinforcement shall be spread evenly over the width of the strips.

(b) Direct bands of rods in four-way systems shall have a width of about (0.4) times the panel width, diagonal bands (0.4) times the average panel widths, and the rods shall be spread evenly in the bands.

(c) The maximum spacing of rods shall not exceed three times the thickness of the slab.

†Sect. 2659. Thickness of Concrete Flat Slabs. — (a) The thickness of a flat slab, and the size and thickness of the dropped panel shall be such that the compressive stress due to bending will not exceed that allowed for concrete on the principal design sections of any strip. The bending moments for which the compressive stress shall be computed shall be assumed to be four thirds those specified for the design of reinforcement.

(b) The width of section for computing compression in concrete due to negative bending at the column head shall be taken as the width of the dropped panel if any; otherwise, half the panel width. The width of other principal sections shall be taken as half the panel width.

(c) The thickness of the slab and the size and thickness of the dropped panel shall be such that shearing stresses computed as specified in section twenty-six hundred and forty-one shall not exceed the stress allowed.

(d) In no case, however, shall the slab thickness be less than one fortieth the length of the panel nor less than six inches.

[*†As amended by Ord. 1943, ch. 8*]

Sect. 2660. Point of Inflection in Flat Slabs.— (a) In a middle strip the point of inflection for slabs without dropped panels shall be assumed at a line (0.33L) distant from the center of the span and for slabs with dropped panels (0.3L) distant from the center of the span.

(b) In a column strip, the point of inflection for slabs without dropped panels shall be at a line 0.33 (L–c) distant from the center of the panel and 0.3 (L–c) for slabs with dropped panel.

Sect. 2661. Arrangement of Flat Slab Reinforcement at Column Heads.— Reinforcement shall be provided not only for the moments at principal design sections but also for moments at intermediate sections. Steel of the full area required for negative moment at the column head shall be continued in the same plane close to the upper surface of the slab to the edge of the dropped panel, and not less than a distance (0.2L) from the center line of the column. Lapped splices shall not be permitted at or near regions of maximum stress except as described in section twenty-six hundred and twenty-six.

Sect. 2662. Arrangement of Flat Slab Reinforcement — Two-way System.— (a) In column strips at least four tenths of the area of steel required at the principal design section for positive moment in the strip shall be in bars of such length and so placed as to reinforce the sections for negative moment at the adjacent column heads. These bars, and other bars for negative reinforcement shall extend into the adjacent panel to a point at least (0.05L) beyond the point of inflection. Not less than one third of the bars used for positive reinforcement in the column strip shall be straight and extend into the dropped panel at least twenty diameters of the bar, but not less than twelve inches; or if no dropped panel is used, shall extend to within (0.125L) of the center line of the columns. The remainder of the bars for positive reinforcement in the column strip shall extend at least (0.33L) on either side of the center line of panel. Not less than one fourth in area of the bars for negative reinforcement of each column strip shall lie directly over the column capital and not less than one half within the width of the dropped panel, if any.

(b) In the middle strip at least one half of the bars for positive moment shall be bent up for negative moment and extend over the bands of the column strips at both sides of the panel to a point at least (0.25L) beyond the center line of columns. The location of the bends shall be such that for a distance (0.15L) for slabs with dropped panels, and (0.125L) for slabs without dropped panels, on each side of the center line of columns, the full reinforcement required for negative moment will be provided in the top face of the slab. The full reinforcement for positive moment in the middle strip shall extend in the bottom face of the slab to a point at least (0.25L) on either side of the panel center line, and at least one half of it shall extend to points (0.325L) on either side of the panel center line for slabs with dropped panels, and (0.35L) for slabs without dropped panels.

Sect. 2663. Arrangement of Flat Slab Reinforcement — Four-way System.— (a) Provisions governing the placing of steel in column strips in two-way systems apply as well to the direct bands in four-way systems.

(b) In diagonal bands, at least four tenths of the area of steel required at the section for positive moment shall be in bars of such length and so placed as to reinforce the negative moment section at the two diagonally opposite column heads. These bars and other bars for negative reinforcement, if any, shall extend into the adjoining panel to points at least (0.4L) beyond a line drawn through the column center perpendicular to the direc-

tion of the band. The straight bars for positive moment in the diagonal bands shall not be shorter than the length of panel center to center of columns.

(c) For negative moment in the middle strip, the required steel shall extend not less than (0.25L) on either side of the column center line.

***Sect. 2664. Flat Slab Reinforcement Other than Two-way or Four-way.**— Arrangement of reinforcement other than two-way or four-way shall provide reinforcing at the principal design sections and at intermediate sections equivalent to that specified above. All such arrangements shall be subject to the approval of the commissioner.

[**As amended by Ord. 1943, ch. 8*]

Sect. 2665. Discontinuous Flat Slab Panels.— (a) In panels adjacent to an exterior wall and other panels where the slab is discontinuous on one or two of its edges, the bending on principal design sections parallel to a discontinuous edge shall be assumed at values not less than specified in this section, depending upon the degree of restraint in bending furnished by the support at such discontinuous edge.

(b) The numerical sum of the positive bending moment at mid-span and the average of the negative bending moments at the discontinuous edge and at the first interior supports for a full panel width, for the design of tensile reinforcement, shall be assumed as not less than

$$M_o = 0.10\ WL\left(1 - \frac{c + a}{3\ L}\right)^2$$

in which (L) is the span center to center of columns, walls or other supports; (c) is the diameter of the interior column capital and (a) is the thickness of the exterior support in the direction of the span. A bracket on the inner face of an exterior column shall be ignored in determining the value of (a).

(c) The bending moments for the design of tensile reinforcement in the principal design sections of the several strips shall be assumed, within the range of allowable variation specified in paragraph (b) of section twenty-six hundred and fifty-seven, as follows:—

Bending Moment for Tensile Reinforcement in Wall Panels of Flat Slabs.

Moment.	Two-way Reinforcement.		Four-way Reinforcement.	
	Without Dropped Panel.	With Dropped Panel.	Without Dropped Panel.	With Dropped Panel.
Negligible Restraint at Discontinuous Edge.				
M_{pc}	$0.32M_o$	$0.31M_o$	$0.30M_o$	$0.29M_o$
M_{pm}	$0.26M_o$	$0.25M_o$	$0.30M_o$	$0.29M_o$
M_{nc} (ext.)	$0.05M_o$	$0.05M_o$	$0.05M_o$	$0.05M_o$
M_{nm} (ext.)	$0.05M_o$	$0.05M_o$	$0.05M_o$	$0.05M_o$
M_{nc} (int.)	$0.55M_o$	$0.60M_o$	$0.60M_o$	$0.65M_o$
M_{nm} (int.)	$0.19M_o$	$0.18M_o$	$0.10M_o$	$0.09M_o$

Bending Moment for Tensile Reinforcement in Wall Panels of Flat Slabs.— Continued.

Moment.	Two-way Reinforcement.		Four-way Reinforcement.	
	Without Dropped Panel.	With Dropped Panel.	Without Dropped Panel.	With Dropped Panel.
Moderate Restraint at Discontinuous Edge.				
M_{pc}	$0.29M_o$	$0.27M_o$	$0.26M_o$	$0.25M_o$
M_{pm}	$0.23M_o$	$0.22M_o$	$0.26M_o$	$0.25M_o$
M_{nc} (ext.)	$0.22M_o$	$0.23M_o$	$0.25M_o$	$0.26M_o$
M_{nm} (ext.)	$0.08M_o$	$0.08M_o$	$0.06M_o$	$0.06M_o$
M_{nc} (int.)	$0.50M_o$	$0.55M_o$	$0.55M_o$	$0.60M_o$
M_{nm} (int.)	$0.18M_o$	$0.16M_o$	$0.10M_o$	$0.08M_o$
Full Restraint at Discontinuous Edge.				
M_{pc}	$0.25M_o$	$0.22M_o$	$0.22M_o$	$0.21M_o$
M_{pm}	$0.20M_o$	$0.20M_o$	$0.22M_o$	$0.21M_o$
M_{nc} (ext.)	$0.38M_o$	$0.41M_o$	$0.46M_o$	$0.48M_o$
M_{nm} (ext.)	$0.10M_o$	$0.10M_o$	$0.06M_o$	$0.06M_o$
M_{nc} (int.)	$0.46M_o$	$0.50M_o$	$0.50M_o$	$0.54M_o$
M_{nm} (int.)	$0.16M_o$	$0.15M_o$	$0.10M_o$	$0.08M_o$

(d) If restraint at a discontinuous edge is furnished by a wall, the negative bending at the exterior support may be more nearly evenly distributed between column and middle strips. If the supports at interior column points are less rigid than the column specified in section twenty-six hundred and sixty-nine the positive bending in column and middle strips shall be increased twenty per cent above the tabular values.

(e) Negligible restraint in bending at the discontinuous edge of a flat slab panel shall be considered to be furnished by a supporting wall of masonry or a row of masonry piers or by any support that does not assure as great restraint as that specified as moderate.

(f) Moderate restraint shall be considered to be furnished by a wall of reinforced concrete or by a row of reinforced concrete columns or of steel columns encased in concrete when the slab acts integrally with the support and when the support is not sufficiently rigid to afford full restraint.

(g) Full restraint shall be assumed where the discontinuous edge of a flat slab is supported by a reinforced concrete wall or row of columns with which it acts integrally and when the ratio $\left(\frac{I}{L}\right)$ for the slab is less than the sum of the ratios $\left(\frac{I}{h}\right)$ for the walls or columns, respectively, above and below the

slab. For the purpose of this section (I) is the moment of inertia of the slab, wall or column calculated for the gross area of the concrete and neglecting the reinforcement.

(h) Except in the case of negligible restraint where precautions are taken to avoid restraint, the bending incidental to the restraint shall be transmitted to the supports, with or without the aid of brackets, in such manner that the stresses specified in this code for the materials used shall not be exceeded. The supports shall be made capable of resisting the bending so transmitted in addition to their other loads and forces without excessive stress. The bending moments transmitted shall be assumed to be four thirds those specified in this section for design of the tensile reinforcement of the slab.

(i) The reinforcement for positive bending perpendicular to the discontinuous edge shall extend to this edge and have an embedment of at least six inches in spandrel beams, walls or columns. Reinforcement for negative bending shall be bent or hooked at spandrel beams, walls or columns to provide adequate anchorage. The length and placement of other reinforcement in wall panels shall be adapted from the requirements of sections twenty-six hundred and sixty-one, twenty-six hundred and sixty-two and twenty-six hundred and sixty-three having in view the changed location of the points of inflection.

(j) The half column strip parallel and adjacent to a marginal beam having a depth not greater than one and one half times the slab thickness, or parallel and adjacent to a discontinuous edge without marginal beam, shall be designed to resist at least one half the moments specified for a full interior column strip. The half column strip parallel and adjacent to a marginal beam having a depth greater than one and one half times the thickness of the slab, shall be designed to resist at least one fourth the moments specified for a full column strip.

(k) If a flat slab is supported at a discontinuous edge by a row of columns having brackets extending from the side of the column in a direction parellel to the discontinuous edge which are equivalent to column capitals, the value of (c) parallel to the discontinuous edge shall be the total width of the capital or brackets. If such columns are without brackets the value of (c) parallel to the discontinuous edge shall be taken as the width of the column plus twice the difference between the depth of the marginal beam, if any, and the depth of the slab.

(l) Dropped panels at wall columns may be omitted, provided the allowed unit stresses are not exceeded.

(m) The provisions of section twenty-six hundred and fifty-nine shall apply to wall panels.

Sect. 2666. Marginal Beams in Flat Slabs.— (a) In panels having a marginal beam on one edge or on each of two adjacent edges, whether or not the slab is there discontinuous, the beam shall be designed to carry at least the load superimposed directly upon it, exclusive of the panel load. A marginal beam which has a depth greater than one and one half times the slab thickness, shall be designed to support, in addition to the load super-

imposed directly upon it, a uniformly distributed load equal to at least one fourth the total live and dead load for which the adjacent panel or panels are designed.

(b) Where there is a beam or a bearing wall at the center line of columns in the interior portion of a continuous flat slab, the negative moment at the beam or wall line in the middle strip perpendicular to the beam or wall shall be taken as thirty per cent greater than the negative moment specified in section twenty-six hundred and fifty-seven or section twenty-six hundred and sixty-five for a middle strip. The half column strip adjacent and parallel to and lying on either side of the beam or wall shall be designed to resist moments, at least one fourth of those specified in section twenty-six hundred and fifty-seven or section twenty-six hundred and sixty-five for a column strip. The beam or wall in such cases shall be designed to carry a uniformly distributed load equal to one fourth of the panel loads on both sides in addition to the loads directly imposed upon it.

Sect. 2667. Openings in Flat Slabs.— (a) Openings of any size may be formed in the area common to two intersecting middle strips, provided the total positive and total negative moments as specified in section twenty-six hundred and fifty-seven or section twenty-six hundred and sixty-five are effectually resisted when these total positive and total negative moments are redistributed between the remaining principal design sections to meet the conditions.

(b) In an area common to two column strips, not more than one opening shall be allowed and the greatest dimension of such an opening shall not exceed (0.05L).

(c) In an area common to one column strip and one middle strip, openings shall not interrupt more than one quarter of the bars in either strip when evenly spaced and the equivalent of the bars so interrupted shall be provided by extra reinforcement on both sides of the opening.

(d) An opening larger than allowed by this section shall be completely framed with beams to carry the loads to the columns.

***Sect. 2668. Construction Joints in Flat Slabs.** — Construction joints in flat slabs shall occur preferably midway between columns. Where such joints occur, steel reinforcing shall be provided perpendicular to the joints in addition to the reinforcement required for bending of cross-sectional area equal to one third that required for bending at the joint. Steel rods so provided shall be spaced not over two times the slab thickness, shall be fully anchored for the allowed tensile stress by embedment each side of the joint, and shall be placed in the same plane with the reinforcement provided for bending in each strip.

[**As amended by Ord. 1943, ch. 8*]

†Sect. 2669. Limiting Dimensions of Concrete Columns. — (a) Unless designed as long columns under the provision of section twenty-six hundred and seventy-three, reinforced concrete columns shall not be longer than ten times the least lateral dimension. Struts shall be designed as columns.

(b) In flat slab construction, except as otherwise provided in paragraph (c) of section twenty-six hundred and fifty-seven and paragraph (d) of section twenty-six hundred and sixty-five, the least dimension of a column supporting a floor shall be not less than one fifteenth the average center to center spacing nor less than sixteen inches; and that of a column supporting only a roof not less than one twentieth the average spacing nor less than fourteen inches.

[†*As amended by Ord. 1943, ch. 8*]

Sect. 2670. Unsupported Length of Concrete Columns.— (a) The unsupported length of a column shall be taken as the clear distance between lateral supports. When the lateral support consists of a floor or roof with beams of different depths, the height of the column to the bottom of the deepest beam in a given direction shall be used with the thickness of the column in that direction in computing the slenderness ratio. When free-standing ties or struts are provided for lateral support, they shall be adequate to prevent the column from bending, and the clear distance between supports in any direction shall be used with the thickness of the column in that direction in computing the slenderness ratio.

(b) Concrete column capitals in flat slab construction, and brackets the full width of supported beams which are inclined at least forty-five degrees to the column, may be considered lateral supports.

‡Sect. 2671. Design of Spirally Reinforced Concrete Columns.—

(a) The maximum allowable axial load, P, on columns reinforced with longitudinal bars and closely spaced spirals enclosing a circular core shall not exceed $P = 0.225\ f'_c\ A_g + A_s f_s$. See section 2602 for *symbols*.

(b) The normal working stress in the vertical column reinforcement, f_s, shall be taken at 40% of the minimum specification value of the yield point; viz. 16,000 lbs. per sq. in. for intermediate grade steel and 20,000 per sq. in. for hard grade or rail steel. This reinforcement shall consist of at least six bars and the minimum diameter of the bars shall be five-eighths inch and not less than one per cent nor more than eight per cent of the gross concrete area.

(c) Where lapped splices are required in the longitudinal reinforcement, the minimum amount of lap for deformed bars, where the strength of the concrete is 3000 lbs. per square inch or above, shall be twenty-four diameters of bar of intermediate grade steel and thirty diameters of bar of hard grade steel. For bars of higher yield point, the amount of lap shall be increased in proportion to the normal working stress. When the concrete strengths are less than 3000 lbs. per square inch the amount of lap shall be one-third greater than the values given in this paragraph.

The lapped splices of plain bars shall be at least 25% greater than that given above for deformed bars.

Welded splices or other positive connections may be used instead of lapped splices, if approved.

(d) Spiral reinforcement shall consist of evenly spaced continuous spirals held firmly in place and true to line by at least three vertical spacer bars. The outside diameter of spirals shall be maintained constant and the ends of the spiral wire shall be anchored. Spiral wire may be spliced by lapping one third the circumference of the spiral and hooking the ends, or by welding. The spacing of the spirals shall not exceed one sixth the diameter of the core nor three inches. The ratio of spiral reinforcement, p′, shall not be less than

$$p' = 0.45 \left(\frac{A_g}{A_c} - 1 \right) \frac{f'_e}{f'_s}$$

where p′ is the ratio of volume of spiral reinforcement to the volume of the concrete core (out to out of spirals).

$\frac{A_g}{A_c}$ is ratio of gross area to core area of column.

f'_s is useful limit stress of spiral reinforcement to be taken as 40,000 lbs. per square inch for hot rolled of intermediate grade, 50,000 lbs. per square inch for hard grade and 60,000 lbs. for cold drawn wire.

(e) Spiral and longitudinal reinforcement shall be protected by a covering of concrete cast monolithic with the core not less than one and one half inches thick.

(f) In columns supporting a beam-and-slab floor or roof, the spiral reinforcement shall extend from the floor below at least to one and one half inches above the bottom of the lowest beam of the floor or roof above, which frames into the column.

(g) In columns supporting a flat slab floor or roof the spiral reinforcement shall extend from the floor at least to mid-height of the concrete column capital above.

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 2672. Design of Tied Reinforced Concrete Columns.**— (a) The maximum allowable axial load, P, on columns reinforced with longitudinal bars and separate lateral ties shall not exceed

$$P = 0.18\, f'_c A_g + 0.8 A_s f_s$$

See section 2671 (b) for value of f_s.

(b) The minimum ratio of longitudinal reinforcement shall not be less than one per cent nor more than four per cent of the gross concrete area, also at least four bars shall be used, of minimum diameter of five eighths inch. Clear distance of the face of each bar to the face of the column shall be one and one-half inches plus the thickness of the column tie. Corner rods in columns shall not be nearer to either adjacent surface than two inches plus the thickness of the column tie.

(c) Lateral ties shall be at least one quarter inch in diameter. They shall be spaced not more than twelve inches apart. In columns of rectangular section, containing more than four longitudinal bars cross ties shall be arranged to afford support to all bars.

[**As amended by Ord. 1943, ch. 8*]

***Sect. 2673. Long Columns.**— (a) The axial load on columns which are longer than ten times the least dimension shall not be greater than —

$$P' = P\left(1.3 - 0.03\frac{h}{d'}\right)$$

(b) The maximum allowable load P′ on eccentrically loaded columns in which $\frac{h}{d'}$ exceeds 10 is given by the formula in paragraph (a) in which P is the allowable eccentrically applied load on the short column. In long columns subjected to definite bending stresses, as determined by Sections 2674, 2675, 2676, the ratio shall not exceed 20.

[**As amended by Ord. 1943, ch. 8*]

†Section 2674. Bending in Concrete Columns.— (a) The bending moments in the columns of all reinforced concrete structures shall be determined on the basis of loading conditions and restraint and shall be provided for in the design. When the stiffness and strength of the columns are utilized to reduce the moments in beams, girders and slabs, as in the case of rigid frames, or in other forms of continuous construction wherein column moments are unavoidable, they shall be provided for in the design. In building frames, particular attention shall be given to the effect of unbalanced floor loads on both exterior and interior columns and of eccentric loading due to other cases. Wall columns shall be designed to resist moments produced by

1. Loads on all floors of the building.
2. Loads on a single exterior bay at two adjacent floor levels, or
3. Loads on a single exterior bay at one floor level.

(b) Resistance to bending moments at any floor level shall be provided by distributing the moment between the columns immediately above and below the given floor in proportion to their relative stiffness and condition of restraint. At the roof the moments shall be provided for in the section of the column below.

[*†As amended by Ord. 1943, ch. 8*]

‡Sect. 2675. Combined Axial and Bending Stresses.— (a) In reinforced concrete columns subjected to bending stresses, recognized methods of analysis shall be followed in calculating the stresses due to combined axial load and bending. The maximum fiber stress in compression and in the case of large eccentricities of loading the tensile stresses in the vertical bars, as given in this Part will govern the design.

(b) For designs where the eccentricity is less than 1/2 the overall column width, and the value of $p_g n$ is 0.3 or more, the following formula shall be used to calculate the combined fiber stress in compression.

$$f_c = \frac{p}{A_g}\,\frac{\left[1 + \frac{ec'}{R^2}\right]}{1 + (n-1)\,p_g}$$

where e is the eccentricity of resultant load, measured from the gravity axis.

c′ is the distance from the gravity axis to the extreme fiber in compression.

R is the radius of gyration of the equivalent concrete section.

n is as given in section 2629.

t′ is the overall depth of the section.

The other symbols are as given in section 2602, paragraph (b).

The term $\frac{ec'}{R^2}$ may be replaced by the value $\frac{6e}{t'}$ for rectangular columns and $\frac{8e}{t'}$ for round columns.

(c) For other limitations than mentioned in paragraph (b) more accurate methods of design shall be used to insure that the allowable stresses are not exceeded.

[‡*As amended by Ord. 1943. ch. 8*]

***Sect. 2676. Allowable Combined Axial and Bending Stresses.**—(a) For spiral and tied columns, eccentrically loaded or otherwise subjected to combined axial compression and flexural stress, the maximum allowable compressive fiber stress shall not exceed f_c in

$$f_c = f_a \frac{1 + \frac{ec'}{R^2}}{1 + C\frac{ec'}{R^2}}$$

where f_a is the average allowable stress on an equivalent axially loaded concrete column.

C is the ratio of f_a to the allowable fiber stress for members in flexure; This

$$f_a = \frac{0.225\, f'_c + f_s p_g}{1 + (n-1)\, p_g} \text{ for spiral columns.}$$

$$f_a = 0.8 \left[\frac{0.225\, f'_c + f_s p_g}{1 + (n-1)\, p_g}\right] \text{for tied columns.}$$

$$C = \frac{f_a}{0.45\, f'_c}$$

(b) The allowable tensile stress in the longitudinal reinforcement shall equal that specified for flexural members, provided however that splices in the tensile steel at or near the section of maximum column moment are capable of developing fully the yield point strength of the reinforcement.

(c) When columns are subjected to wind stresses in addition to combined axial loads and bending, the column section need not be increased unless the allowable stress given in paragraph (a) of this section is exceeded by more than one-third.

[**As amended by Ord. 1943, ch. 8*]

*__Sect. 2677. Combination Columns.__ — (a) The axial load on combination columns, in which structural steel columns of rolled or built-up section wrapped with No. 10 gage wire spaced four inches on centers or its equivalent are encased in concrete not less than two inches thick over all of the metal, except rivet heads and connections, shall not exceed

$$P = A_r f'_r \left[1 + \frac{A_c}{100A_r} \right]$$

where A_c is the total area of the concrete = $A_g - A_r$

A_r is the cross-sectional area of the steel column

f'_r is the allowable stress for unencased steel column, as allowed in Part 28.

(b) The concrete shall be at least equal in quality to two thousand pound concrete as specified in section twenty-six hundred and ten.

(c) Stress allowed in paragraph (a) shall be allowed in compression members of trusses, if the requirements of this section are fulfilled.

[*_As amended by Ord. 1943, ch. 8_]

†**Sect. 2678. Concrete Walls.** — (a) Reinforced concrete walls shall have at least the thickness specified in Part 14. Reinforced concrete walls shall be reinforced in two directions at right angles by steel reinforcement having an effective area in each direction of not less than (0.0025) times the cross-sectional area of the concrete. In walls less than six inches thick the reinforcement may be placed at mid-thickness of the wall unless calculated bending requires it to be placed near one face. In walls six inches or more in thickness, not less than half the steel required by this paragraph shall be placed as close to each face of the wall as requirements for fire and rust protection will allow. Such steel reinforcement shall be in the form of reinforcing bars not less than three-eighths inch in diameter and spaced not over eighteen inches apart or of approved wire mesh.

(b) Protective covering for reinforcing shall be as required in section 2627 and Part 22, except as provided in paragraph (a).

(c) Provide construction joints and expansion joints for walls, copings and balustrades, together with drainage and weep holes as required by the commissioner.

(d) The capacity of a reinforced concrete wall to support a vertical load shall be computed in the same manner as specified in sections twenty-six hundred and seventy-two, twenty-six hundred and seventy-three, and twenty-six hundred and seventy-four for columns with lateral ties. The vertical reinforcement shall not be assumed to contribute to the capacity of the wall unless it conforms to the requirements for longitudinal reinforcement in columns and is stayed by lateral ties perpendicular to the wall.

[†_As amended by Ord. 1943, ch. 8_]

‡**Sect. 2679. Sloped or Stepped Concrete Footings.** — (a) Footings shall be designed to sustain the applied loads without exceeding the allowable working stresses in this part. Allowable bond stress shall be reduced 25% from the stresses allowed in section 2629 in all tension regions requiring moment reinforcement in more than one direction.

(b) Footings may have sloped or stepped tops provided the thickness of the footing above the reinforcement shall not be less than six inches for footings

on soil, nor less than nine inches for footings on piles, also plain concrete footings may have sloped or stepped tops provided the thickness is not less than twelve inches.

(c) Concrete in reinforced footings shall be proportioned for a strength of at least eighteen hundred pounds per square inch.

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 2680. Bending in Concrete Footings. (Critical Sections.)**— (a) The critical section for bending in a concrete footing which supports a concrete column or pedestal, shall be considered to be at the face of the column or pedestal. Where a steel or cast iron column base rests on a concrete footing, moments in the footing shall be considered at the middle and at the edge of the base and the larger one shall be used in the design. Loads shall be considered as uniformly distributed over the column. In the case of columns other than square or rectangular the critical section shall be taken at the side of a concentric square of equal area. For concrete footings under masonry walls, moments in the footing shall be taken midway between the middle and the edge of the wall.

(b) The bending moment at a critical section shall be computed from all the forces acting on the footing on one side of the section (excluding the weight of the footing). Critical sections for bond and shear shall be taken for the same loading and same plane as for bending. Bonds shall also be investigated at planes where changes in concrete section or reinforcement occur. The critical section for diagonal tension in footings on soil shall be considered as the concentric vertical section through the footing at a distance d from each face of the column pedestal or wall. This depth d should be measured from the top of the section to the plane of the centroid of longitudinal reinforcement. The critical section for diagonal tension for footing supported on piles should be considered as the concentric vertical section through the footing at a distance $\frac{d}{2}$ from each face of the column, pedestal or wall, and any piles whose centers are at, or outside this section should be included in computing the shear.

(c) Shear in footings shall be computed as specified in section 2642.

(d) For reinforced concrete columns, the critical section for transverse bending should be taken at the faces of the columns or pedestals. For footings under metallic column bases, the critical section should be assumed midway between the face of the column and the edge of the metallic base. The transverse reinforcement should be divided into groups proportionate in sectional area to the column loads. The transverse reinforcement at each column should be placed uniformly within a band having a width not greater than the width of the column plus twice the effective depth of the footing. Longitudinal reinforcement should be distributed over the whole width.

The critical sections for diagonal tension in combined footings should be taken at the faces of the supported members for all beam elements and also for all projecting cantilevers.

[**As amended by Ord. 1943, ch. 8*]

***Sect. 2681. Plain Concrete Footings.**— (a) The critical section of plain concrete footings shall be computed and cast as a monolithic section of the entire width and depth measured from a plane two inches above the bottom of the footing. The maximum tensile fiber stress in the concrete shall not exceed 0.025 of the ultimate compression strength of the concrete. The average shearing stress shall not exceed 0.02 of the ultimate compressive strength of the concrete, computed on a concentric vertical section through the footing at a distance (d′–2) inches from each face of the column, pedestal or wall, excluding two inches of depth nearest the bottom.

(b) The area of the top of the footing shall not be less than the amount given by formula section 2682.

[**As amended by Ord. 1943, ch. 8*]

†Sect. 2682. Bearing on Concrete Footing.—(a) The compressive stress in the longitudinal reinforcement at the base of a reinforced concrete column shall be transferred to a pedestal or to a footing by extending the bars into the pedestal or footing or by use of dowels. There shall be at least one dowel for each column bar, and the total sectional area of the dowels shall be not less than the sectional area of the longitudinal reinforcement in the column. The dowels or column bars shall extend into the column and into the pedestal or footing the distance required to transfer to the concrete, by allowable bond stress, their full working strength. Hooks shall not be considered as adding to bond resistance in compression. The unit compressive stress on the top of the pedestal or footing directly under the column or base shall not be greater than that determined by the formula

$$\frac{f'_c}{16}\left[3 + \frac{A}{A'}\right]$$

nor greater than ($0.375\ f'_c$) unless the pier pedestal or footing is reinforced laterally as provided in paragraph (b).

(b) When lateral reinforcement in the form of a spiral or hoops is provided in the pedestal or footing the unit stress in bearing for the core area may be increased to ($1 + 2.5\ np'$) times that allowed for plain concrete, but no area outside the outer face of the spiral or hoops shall be considered.

[*†As amended by Ord. 1943, ch. 8*]

‡Sect. 2683. Pedestals — Plain Concrete.—(a) The compressive unit stress on the gross area of a concentrically loaded pedestal or the upper surface of a pedestal footing shall not exceed $0.25\ f'_c$.

(b) The depth and width of a pedestal or pedestal footing shall be determined by consideration of shear and bending stresses as given in section 2681. However, in no case shall the depth be greater than three times its least width.

(c) A pedestal or pedestal footing supported directly on piles shall have a mat of reinforcing, of cross-sectional area not less than 0.20 square inch per foot of width in each direction, placed three inches above the top of the piles.

[*‡As amended by Ord. 1943, ch. 8*]

PART 27.*

PRECAST GYPSUM CONCRETE.

Section 2701. Precast Gypsum Concrete. — (a) Precast gypsum concrete units may be used for floor construction and shall be of uniform thickness except for rabbets at support and shall be solid; such units may be used for roof construction and shall be of uniform thickness, whether solid or hollow, or recessed on the under side. The span of precast gypsum concrete shall not exceed four feet in floors and six feet in roofs except in so-called suspension construction in which the span for floors shall not exceed six feet and in roofs shall not exceed eight feet. For the purpose of this section any span over three feet shall be called long span.

(b) Except as otherwise provided in paragraph (c) of this section, precast gypsum concrete units shall have not less than the following thicknesses: —

(1) Solid units in roofs shall be not less than two inches thick, nor if long span, less than three inches thick.

(2) Solid units in floors shall be not less than two and one half inches thick, nor, if long span, less than four inches thick.

(3) Hollow units in roofs shall be not less than three inches nor the shell in compression less than three fourths inch thick; if long span, the units shall be not less than five inches thick nor the shell in compression less than one and three eighths inches thick.

(4) Recessed units in roofs shall be not less than five inches thick nor the panel less than one and three eighths inches thick.

(c) Precast solid reinforced gypsum concrete units not more than fifteen inches wide and bound on the long edges with structural or pressed sheet steel of approved design anchored to the units shall be not less than two inches thick. If the length of units is not less than one and one half times the span and the steel bearing on the edges is designed to interlock with adjoining units in the manner of tongue and groove, and if of sufficient strength to transmit the load on one unit to adjoining units, the end joints may be staggered at random provided they are not less than two feet apart and the construction may be designed as continuous.

(d) Precast gypsum concrete units for floor and roof construction shall be reinforced and unless the shape or marking of the unit is such as to ensure its being placed right side up, the reinforcing shall be symmetrical so that the unit can support its load either side up.

(e) Precast gypsum concrete units shall be designed in accordance with conditions outlined in paragraph (g) below.

(f) Precast gypsum concrete units shall not be used structurally in floors or roofs until the manufacturer thereof has submitted satisfactory evidence of their quality and the commissioner has given his approval. Approval shall be conditioned upon such requirements as to design, materials, methods of manufacture, erection and support as the commissioner shall determine.

(g) The basis of design and materials shall be consistent with the following requirements to qualify for approval:

(1) Precast gypsum concrete shall contain not more than three per cent wood chips, shavings or fibre by weight of dry materials before mixing.

(2) Precast gypsum concrete shall have a minimum strength of one thousand pounds per square inch.

(3) In designing the precast gypsum concrete the modulus of elasticity shall be considered as six hundred thousand pounds per square inch.

(4) In design of structural members of reinforced gypsum concrete the unit stress in the concrete shall not exceed the following allowable values:

Maximum unit compression in bending	$0.25\ f_g$
Axial compression or bearing	$0.20\ f_g$
Bond on plain bars or wires	$0.02\ f_g$
Bond on deformed bars or wire mesh	$0.04\ f_g$
Shear (straight rods or wires)	$0.02\ f_g$
Shear (reinforcement anchored)	$0.03\ f_g$

In this table (f_g) indicates the ultimate compressive strength of the gypsum concrete as approved by paragraph (f) of this section.

Unit stress in steel reinforcement shall not exceed the values allowed in Part 26.

(5) Fire protection coverage for steel reinforcement in gypsum shall be limited to a minimum of one-half inch in thickness.

(6) In no case shall gypsum concrete be used for a wearing surface in gypsum construction.

(7) Gypsum concrete shall not be used in floors of garages, dance halls, gymnasiums, armories or floors used for any other purpose where subject to extreme vibration, impact, or heavy, moving load concentrations.

[**As amended by Ord. 1943, ch. 8*]

PART 28

STEEL AND IRON

ACKNOWLEDGEMENTS

The revision of Part 28 of the Building Code was accomplished by the Technical Committee, the membership of which is given below. Much time and effort were expended by the Technical Committee in specifying modern practice for steel and iron construction. When the 1963 specifications of the American Institute of Steel Construction became available, the Committee decided to adapt those specifications, and in the same format, to the requirements of the Boston Building Code, making changes appropriate to Boston in the Institute text. Adaptations from the 1962 publication of the American Iron and Steel Institute covering Light Gage Cold-Formed Steel Structural Members have also been included. Valuable suggestions and criticisms were received from representatives of trades and professions concerned with the building industry. The work was reviewed and recommended for approval by an Advisory Committee appointed by Mayor John F. Collins.

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Massachusetts Institute of Technology
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Col. Robert E. York, Building Commissioner, Boston

PART 28

STEEL AND IRON

Ordinances of 1963, Chapter 8

Chapter 479 of the Acts of 1938 was amended, by striking out Part 28 as amended by chapter 8 of the Ordinances of 1943, and chapter 2 of the Ordinances of 1955, and inserting in place thereof a new Part 28.

Passed by the City Council, October 7, 1963.

Approved by the Mayor, October 9, 1963.

Ordinances of 1964, Chapter 6

Section 28 — 1.6A of Part 28 of Chapter 479 of the Acts of 1938, as appearing in Chapter 8 of the Ordinances of 1963, is hereby amended by striking out Subdivision 1.6.1A and inserting in place thereof a new subdivision; and Subsection 1.29.2.2 of Section 28 — 1.29 of Part 28, as so appearing, is amended by striking out Formula (27) and inserting in place thereof a new Formula (27).

Passed by the City Council, August 3, 1964.

Approved by the Mayor, August 5, 1964.

October 1, 1964

PART 28
STEEL AND IRON

NOTE.—Sections 28-1.1A through Section 28-1.26.5 and Sections 28-2.0 through Section 28-2.9 of this Part are based on the Specification for the Design, Fabrication and Erection of Structural Steel for Buildings as adopted April 17, 1963 by the American Institute of Steel Construction. Sections 28-1.28 through 28-1.28.3.3 are based on the Specification for the Design of Light Gage Cold-Formed Steel Structural Members, 1962 Edition, of American Iron and Steel Institute. Where the letter "A" appears as a part of the section numbering a change from the original text of the reference specification applicable to Boston has been made.

SECTION

NOMENCLATURE

A_b Nominal body area of a bolt
A_c Actual area of effective concrete flange in composite design
A_{bc} Planar area of web at beam-to-column connection
A_f Area of compression flange
A_s Area of steel beam in composite design
A_{st} Cross-sectional area of stiffener or pair of stiffeners
A_w Area of girder web
B Coefficient used in column formula for plastic design
C_b Bending coefficient dependent upon moment gradient; equal to

$$1.75 - 1.05\left(\frac{M_1}{M_2}\right) + 0.3\left(\frac{M_1}{M_2}\right)^2$$

C_c Column slenderness ratio dividing elastic and inelastic buckling; equal to

$$\sqrt{\frac{2\pi^2 E}{F_y}}$$

C_m Coefficient applied to bending term in interaction formula and dependent upon column curvature caused by applied moments
C_v Ratio of "critical" web stress, according to the linear buckling theory, to the shear yield point of web material; equal to

$$\frac{\pi^2 Ek\sqrt{3}}{12(1 - v^2)(h/t)^2 F_y}$$

D Factor depending upon type of transverse stiffeners
E Modulus of elasticity of steel (29,000,000 pounds per square inch)
E_c Modulus of elasticity of concrete
F_a Axial compressive stress permitted in the absence of bending moment
F_{as} Axial compressive stress, permitted in the absence of bending moment for bracing and other secondary members
F_b Bending stress permitted in the absence of axial force
F'_b Allowable bending stress in compression flange of plate girders as reduced because of large web depth-to-thickness ratio
F'_e Euler stress divided by factor of safety; equal to

$$\frac{149{,}000{,}000}{\left(\frac{Kl_b}{r_b}\right)^2}$$

F_p Allowable bearing stress
F_t Allowable tensile stress
F_v Allowable shear stress
F_y Specified minimum yield point of the type of steel being used (pounds per square inch unless otherwise noted)
G Coefficient used in column formula in plastic design
H Coefficient used in column formula in plastic design
I_{tr} Moment of inertia of transformed composite section

J Coefficient used in column formula in plastic design
K Effective length factor
L Span length, in feet
L_u Maximum unbraced length of compression flange, in feet, for which full bending stress is permitted by Formula (5B)
M Moment
M_1 Smaller end moment on unbraced length of beam-column
M_2 Larger end moment on unbraced length of beam-column
M_D Moment produced by dead load
M_L Moment produced by live load
M_o Reduced plastic moment
M_p Plastic moment
N Length of bearing of applied load
P Applied load
P_y Plastic axial load: equal to profile area times specified minimum yield point
R Reaction or concentrated transverse load applied to beam or girder
S_s Section modulus of steel beam used in composite design, referred to the tension flange
S_{tr} Section modulus of transformed composite cross-section, referred to the tension flange
T_b Proof load of a high strength bolt
V Shear on beam
V_h Total horizontal shear to be resisted by connectors
V_u Shear produced by "ultimate" load in plastic design
Y Ratio of yield point of web steel to yield point of stiffener steel
a Clear distance between transverse stiffeners
a' Distance required at ends of welded partial length cover plate to develop stress
b Effective width of concrete slab
b_f Flange width of rolled beam or plate girder
c Distance from neutral axis to top of concrete slab
d Depth of beam or girder. Also diameter of roller or rocker bearing
e Horizontal displacement, in the direction of the span between top and bottom of simply supported beam at its ends
f_a Computed axial stress
f_b Computed bending stress
f'_c Specified compression strength of concrete at 28 days
f_t Computed tensile stress
f_v Computed shear stress, in pounds per square inch
f_{vs} Shear between girder web and transverse stiffeners, in pounds per linear inch of single stiffener or pair of stiffeners
g Transverse spacing between fastener gage lines
h Clear distance between flanges of a beam or girder
k Coefficient relating linear buckling strength of a plate to its dimensions and condition of edge support. Also distance from outer face of flange to web toe of fillet
l Actual unbraced length in inches

l_b Actual unbraced length in plane of bending, in inches
l_{cr} Critical unbraced length adjacent to plastic hinge, in inches
n Modular ratio; equal to E/E_c
q Allowable horizontal shear to be resisted by a connector
r Governing radius of gyration
r_b Radius of gyration about axis of concurrent bending
r_y Lesser radius of gyration
s Spacing (pitch) between successive holes in line of stress
t Girder or beam web thickness
t_f Flange thickness
t_t Thickness of thinner part jointed by partial penetration groove weld
w Web thickness of plastically designed rolled beams. Also length of channel shear connectors
ν Poisson's ratio
$\geq$ Is equal to or greater than
$\leq$ Is equal to or less than
$>$ Is greater than
$<$ Is less than

Section 28–1.0. Design of Steel and Iron. — Structures of steel and iron shall be designed by methods admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which they are subject without exceeding the stresses allowed in this part for the various members and the materials thereof.

Sect. 28–1.1A. Plans and Drawings.

1.1.1A. Plans. — The plans (design drawings) shall show a complete design with sizes, sections, and the relative locations of the various members. Floor levels, column centers, and offsets shall be dimensioned. Plans shall be drawn to a scale large enough to convey the information adequately.

Plans shall indicate the class or classes of construction (as defined in Sect. 28–1.2A) to be employed, and they shall be supplemented by such data concerning the assumed loads, shears, moments and axial forces to be resisted by all members and their connections, as may be required for the proper preparation of the shop drawings.

Where joints are to be assembled with high strength bolts and are required to resist shear between the connected parts, the plans shall indicate the type of connections to be provided, namely, friction or bearing.

Camber of trusses, beams and girders, if required, shall be called for on the design drawings.

1.1.2A. Shop Drawings. — Shop drawings, giving complete information necessary for the fabrication of the component parts of the structure, including the types of material, the location, type and size of all rivets, bolts and welds, shall be prepared in advance of the actual fabrication. They shall clearly distinguish between shop and field rivets, bolts and welds.

Shop drawings shall be made in conformity with the best modern practice and with due regard to safety, speed and economy in fabrication and erection.

1.1.3. Notations for Welding. — Note shall be made on the plans and on the shop drawings of those joints or groups of joints in which it is especially important that the welding sequence and technique of welding be carefully controlled to minimize locked-up stresses and distortion.

Weld lengths called for on the plans and on the shop drawings shall be the net effective lengths.

1.1.4A. Standard Symbols and Nomenclature. — Welding symbols used on plans and shop drawings shall preferably be the American Welding Society symbols. Other adequate welding symbols may be used, provided a complete explanation thereof is shown on the plans or drawings.

Sect. 28–1.2A. Classes of Construction. — Three basic classes of construction and associated design assumptions are permissible under the respective conditions stated hereinafter, and each will govern in a specific manner the size of members and the types and strength of their connections.

Class A, commonly designated as "rigid-frame" (continuous frame), assumes that beam-to-column connections have sufficient rigidity to hold virtually unchanged the original angles between intersecting members.

Class B, commonly designated as "conventional" or "simple" framing (unrestrained, free-ended), assumes that the ends of beams and girders are connected for shear only, and are free to rotate under load.

Class C, commonly designated as "semi-rigid framing" (partially restrained), assumes that the connections of beams and girders possess a dependable and known moment capacity intermediate in degree between the complete rigidity of Class A and the complete flexibility of Class B.

The design of all connections shall be consistent with the assumptions as to class of construction called for on the design drawings.

Class A construction is unconditionally permitted under this Code. Two different methods of design are recognized. Within the limitations laid down in Sect. 28–2.1A, members of continuous frames, or continuous portions of frames, may be proportioned, on the basis of their maximum predictable strength, to resist the specified design loads multiplied by the prescribed load factors. Otherwise Class A construction shall be designed, within the limitations of Sect. 28–1.5A, to resist the stresses produced by the specified design loads, assuming moment distribution in accordance with the elastic theory.

Class B construction is permitted under this Code, subject to the stipulations of the following paragraph wherever applicable. Beam-to-column connections with seats for the reactions and with top clip angles for lateral support only are classed under Class B.

In tier buildings, designed in general as Class B construction (that is, with beam-to-column connections other than wind connections flexible) the distribution of the wind moments between the several joints of the frame may be made by a recognized empirical method provided that the wind connections.

designed to resist the assumed moments, are adequate to resist the moments induced by the gravity loading and the wind loading at the increased unit stresses permitted therefor.

Class C (semi-rigid) construction will be permitted only upon evidence that the connections to be used are capable of furnishing, as a minimum, a predictable proportion of full end restraint. The proportioning of main members joined by such connections shall be predicated upon no greater degree of end restraint than this minimum.

Classes B and C construction may necessitate some non-elastic but self-limiting deformation of a structural steel part.

Sect. 28–1.3A. Loads and Forces. — See Part No. 23, "Live and Dead Loads."

Sect. 28–1.4A. Materials.

1.4.1A. Structural Steel.

1.4.1.1. — Structural steel shall conform to one of the following specifications:

Steel for Bridges and Buildings, ASTM A7-61T
Structural Steel for Welding, ASTM A373-58T
Structural Steel, ASTM A36-62T
High-Strength Structural Steel, ASTM A440-63T
High-Strength Low-Alloy Structural Manganese Vanadium Steel, ASTM A441-63T
High-Strength Low-Alloy Structural Steel, ASTM A242-63T

1.4.1.2A. — Certified mill test reports or certified reports of tests, made by the fabricator or a testing laboratory in accordance with ASTM A6-62T and the governing specification, shall constitute evidence of conformity with one of the above ASTM Specifications. Additionally, the fabricator shall, if requested, provide an affidavit stating that the structural steel furnished meets the requirements of the grade specified.

1.4.1.3. — Unidentified steel, if free from surface imperfections, may be used for parts of minor importance, or for unimportant details, where the precise physical properties of the steel and its weldability would not affect the strength of the structure.

1.4.1.4. — Steels of higher strength than are covered by the above mentioned ASTM Specifications may be used provided the design is based upon the minimum properties of such higher strength steel as certified by the manufacturer's test reports and approved by the Building Commissioner.

1.4.2A. Other Metals. — Cast steel shall conform to one of the following specifications:

Mild-to-Medium-Strength Carbon-Steel Castings for General Application, ASTM A27-62, Grade 65-35
High-Strength Steel Castings for Structural Purposes, ASTM A148-60, Grade 80-50

Certified test reports shall constitute sufficient evidence of conformity with the specifications.

Steel forgings shall conform to one of the following specifications:

Carbon Steel Forgings for General Industrial Use, ASTM A235-62T, Class CI, F and G. (Class CI Forgings that are to be welded shall be ordered in accordance with Supplemental Requirements S5 of A235.)

Alloy Steel Forgings for General Industrial Use, ASTM A237-62T, Class A

Certified test reports shall constitute sufficient evidence of conformity with the specifications.

Steel for light gage structural members cold-formed to shape shall conform to the following specifications:

(a) *Flat-Rolled Carbon-Steel Sheets of Structural Quality,* ASTM A245-62aT

(b) *Hot-Rolled Carbon-Steel Strip of Structural Quality,* ASTM A303-62T

(c) *High Strength Low Alloy Cold-Rolled Steel Sheets and Strip,* ASTM A374-62T

(d) *High Strength Low Alloy Hot-Rolled Steel Sheets and Strip,* ASTM A375-62T

(e) *Zinc-Coated (Galvanized) Steel Sheets of Structural Quality, Coils and Cut Lengths,* ASTM A446-60T

(f) Steel of higher strength than is covered by the above mentioned ASTM Specifications may be used provided the design is based upon the minimum properties of such higher strength steel as certified by the manufacturer's test reports.

Cast iron to *Standard Specifications for Gray Iron Castings,* ASTM A48-56, Class 25.

Pipe for concrete-filled pipe columns to *Tentative Specifications for Welded and Seamless Steel Pipe,* ASTM A-53-62T, Grade B.

Structural steel members installed in buildings built in the year 1924 or earlier shall not be stressed in excess of 16000 psi. Similar members installed after 1924 and prior to the year 1943, and after 1942 and prior to the adoption of this Code shall not be stressed in excess of 18000 psi and 20000 psi respectively.

Structural steel which has previously been used in a building or other structure or which has been fabricated for such use, shall not be used in another building or structure except with the approval of the Commissioner and under such conditions as he may in each case specify.

The Commissioner may require reasonable tests from time to time of metals and alloys to determine their quality and whether they conform to the requirements of this part.

1.4.3A. Rivet Steel. — Rivet steel shall conform to one of the following specifications:

Structural Rivet Steel, ASTM A141-58
High-Strength Structural Rivet Steel, ASTM A195-59
High-Strength Structural Alloy Rivet Steel, ASTM A406-59

Certified mill test reports shall constitute sufficient evidence of conformity with the specifications in accordance with Sect. 1.4.1.2A.

1.4.4A. Bolts. — High strength steel bolts shall conform to one of the following specifications:

High-Strength Steel Bolts for Structural Joints, ASTM A325-61T

Quenched and Tempered Alloy Steel Bolts and Studs with Suitable Nuts, ASTM A354-58T, Grade BC

Other bolts shall conform to the *Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners*, ASTM A307-61T, hereinafter designated as A307 bolts.

Manufacturer's certification shall constitute sufficient evidence of conformity with the specifications.

1.4.5A. Filler Metal for Welding. — Welding electrodes for manual shielded metal-arc welding shall conform to the E60 or E70 series of the *Specification for Mild Steel Arc-Welding Electrodes*, ASTM A233-58T.

Bare electrodes and granular flux used in the submerged-arc process shall conform to the provisions of Sect. 28–1.17.3.

Manufacturer's certification shall constitute sufficient evidence of conformity with the specifications.

Sect. 28–1.5A. Allowable Unit Stresses. — All components of the structure shall be so proportioned that the unit stress, in pounds per square inch, shall not exceed the allowable stress specified in the appropriate section of Part 28 for the particular component.

1.5.1. Structural Steel.

1.5.1.1. Tension. — On the net section, except at pin holes

$$F_t = 0.60F_y$$

On the net section at pin holes in eyebars, pin-connected plates or built-up members

$$F_t = 0.45F_y$$

1.5.1.2. Shear. — On the gross section

$$F_v = 0.40F_y$$

For shear calculation, the gross section of beams and plate girders may be taken as the product of the overall depth and the thickness of the web. (See Sect. 28–1.10 for reduction required for thin webs.)

1.5.1.3A. Compression.

1.5.1.3.1. — On the gross section of axially loaded compression members when $\frac{Kl}{r}$, the largest effective slenderness ratio of any unbraced segment as defined in Sect. 28–1.8A, is less than C_c

$$F_a = \frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2}\right] F_y}{\text{F.S.}} \qquad \text{Formula (1)}$$

where

$$\text{F.S.} = \text{factor of safety} = \frac{5}{3} + \frac{3(Kl/r)}{8C_c} - \frac{(Kl/r)^3}{8C_c^3}$$

and

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}}$$

1.5.1.3.2. — On the gross section of axially loaded columns when l/r exceeds C_c

$$F_a = \frac{149{,}000{,}000}{(Kl/r)^2} \qquad \text{Formula (2)}$$

1.5.1.3.3A. — On the gross section of axially loaded bracing and secondary members, when l/r exceeds 120 and the end conditions are such as to provide restraint with respect to rotation,

$$F_{as} = \frac{F_a \text{ (by Formula 1 or 2)}}{1.6 - \dfrac{l}{200r}} \qquad \text{Formula (3)}$$

in which l is the full unbraced length of the member.

1.5.1.3.4. — On the gross area of plate girder stiffeners

$$F_a = 0.60F_y$$

1.5.1.3.5. — On the web of rolled shapes at the toe of the fillet (crippling, see Sect. 28–1.10.10)

$$F_a = 0.75F_y$$

1.5.1.4. Bending.

1.5.1.4.1. — Tension and compression on extreme fibers of laterally supported compact rolled shapes and compact built-up members having an axis of symmetry in the plane of loading

$$F_b = 0.66F_y$$

(In order to qualify as a compact section the width-thickness ratio of projecting elements of the compression flange shall not exceed $1{,}600/\sqrt{F_y}$, except that, for rolled shapes, an upward variation of 3 percent may be tolerated. The width-thickness ratio of flange plates in box sections and flange cover plates included between longitudinal lines of rivets, high strength bolts or welds shall not exceed $6{,}000/\sqrt{F_y}$. The depth-thickness ratio of the web, d/t, shall not exceed $13{,}300/\sqrt{F_y}$. When subjected to combined axial force and bending moment d/t shall not exceed $13{,}300(1-1.43f_a/F_a)/\sqrt{F_y}$ except that it need not be less than $8{,}000\sqrt{F_y}$. Flanges of compact built-up sections shall be continuously connected to the web or webs. Such members are deemed to be supported laterally when the distance, in inches, between points of support of the compression flange does not exceed $2{,}400b_f/\sqrt{F_y}$ nor $20{,}000{,}000A_f/dF_y$.)

Beams and girders which meet the requirements of the preceding paragraph and are continuous over supports or are rigidly framed to columns by means of rivets, high strength bolts or welds, may be proportioned for $9/10$ of the negative moments produced by gravity loading which are maximum at points of support, provided that, for such members, the maximum positive moment shall be increased by $1/10$ of the average negative moments. This reduction shall not apply to moments produced by loading on cantilevers. If the negative moment is resisted by a column rigidly framed to the beam or girder, the $1/10$ reduction may be used in proportioning the column for the combined axial and bending loading, provided that the unit stress, f_a due to any concurrent axial load on the member, does not exceed $0.15F_a$.

1.5.1.4.2A. — Tension and compression on extreme fibers of members, except channels, unsymmetrical about the plane of loading supported as in Sect. 28–1.5.1.4.1 in the region of compression stress

$$F_b = 0.60F_y$$

1.5.1.4.3. — Tension and compression on extreme fibers of box-type members whose proportions do not meet the provisions of a compact section but do conform to the provisions of Sect. 28–1.9

$$F_b = 0.60F_y$$

1.5.1.4.4. — Tension on extreme fibers of other rolled shapes, built-up members and plate girders

$$F_b = 0.60F_y$$

1.5.1.4.5A. — Compression on extreme fibers of rolled shapes, plate girders and built-up members having an axis of symmetry in the plane of their web (other than box-type beams and girders), the larger value computed by Formulas (4) and either (5A) or (5B) as applicable, but not more than $0.60F_y$

$$F_b = \left[1.0 - \frac{(l/r)^2}{2C_c{}^2C_b}\right] 0.60F_y{}^* \qquad \text{Formula (4)}$$

In case $\dfrac{ld}{A_f} \leq \dfrac{40{,}000{,}000}{F_y}$ use

$$F_b = \left(0.67 - \frac{F_y}{108{,}000{,}000}\,\frac{ld}{A_f}\right) F_y \qquad \text{(5A)}$$

In case $\dfrac{ld}{A_f} \geq \dfrac{40{,}000{,}000}{F_y}$ use

$$F_b = \frac{12{,}000{,}000}{\dfrac{ld}{A_f}} \qquad \text{(5B)}$$

where l is the unbraced length of the compression flange; r is the radius of gyration of a tee section comprising the compression flange plus one-sixth of

* Where l/r is less than 40, stress reduction according to Formula (4) may be neglected.

the web area, about an axis in the plane of the web; A_f is the area of the compression flange; C_c is defined in Sect. 28–1.5.1.3 and C_b, which can conservatively be taken as unity, is equal to

$$C_b = 1.75 - 1.05\left(\frac{M_1}{M_2}\right) + 0.3\left(\frac{M_1}{M_2}\right)^2, \quad \text{but not more than } 2.3$$

where M_1 is the smaller and M_2 the larger bending moment at the ends of the unbraced length, taken about the strong axis of the member, and where M_1/M_2, the ratio of end moments, is positive when M_1 and M_2 have the same sign (single curvature bending) and negative when they are of opposite signs, (reverse curvature bending). When the bending moment at any point within an unbraced length is larger than that at either end of this length the ratio M_1/M_2 shall be taken as unity. See Sect. 28–1.10 for further limitation in plate girder flange stress.

1.5.1.4.6A. — Compression on extreme fibers of channels, loaded in the plane parallel to the web which passes through the shear center, the value computed by Formulas (5), or (5B), but not more than

$$F_b = 0.60F_y$$

1.5.1.4.7. — Tension and compression on extreme fibers of pins

$$F_b = 0.90F_y$$

1.5.1.4.8. — Tension and compression on extreme fibers of rectangular bearing plates

$$F_b = 0.75F_y$$

1.5.1.5. Bearing (on contact area).

1.5.1.5.1. — Milled surfaces, including bearing stiffeners, and pins in reamed, drilled or bored holes, pounds per square inch

$$F_p = 0.90F_y{}^*$$

1.5.1.5.2. — Expansion rollers and rockers, pounds per linear inch

$$F_p = \left(\frac{F_y{}^* - 13{,}000}{20{,}000}\right) 660d$$

where d is the diameter of roller or rocker in inches.

1.5.2A. Rivets and Bolts.

1.5.2.1A. — Allowable unit tension and shear stresses on rivets, bolts and threaded parts (pounds per square inch of area of rivets before driving or unthreaded body area of bolts and threaded parts) shall be as given in Table 28–1.5.2.1A

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* When parts in contact have different yield points, F_y shall be the smaller value.

Table 28-1.5.2.1A

Description of Fastener	Tension (F_t)	Shear (F_v)	
		Friction-Type Connections	Bearing-Type Connections
A141 hot-driven rivets............	20,000		15,000
A195 and A406 hot-driven rivets...	27,000		20,000
A307 bolts and threaded parts of A7 and A373 steel.................	14,000		10,000
Threaded parts of other steels.....	$0.40F_y$		$0.30F_y$
A325 bolts when threading is *not* excluded from shear planes......	30,000	15,000	15,000
A325 bolts when threading is excluded from shear planes........	30,000	15,000	22,000
A354, Grade BC, bolts when threading is *not* excluded from shear planes........................	37,500	20,000	20,000
A354, Grade BC, when threading is excluded from shear planes......	37,500	20,000	24,000

1.5.2.2. — Allowable bearing stress on projected area of bolts in bearing type connections and on rivets

$$F_p = 1.35F_y$$

where F_y is the yield point of the connected part. (See footnote to Sect. 1.5.1.5.)

(Bearing stress not restricted in friction-type connections assembled with A325 and A354, Grade BC, bolts.)

1.5.3. Welds (stress in pounds per square inch of throat area).

1.5.3.1. Fillet, Plug, Slot and Partial Penetration Groove Welds.

Stress in fillet, plug, and slot welds, tension stress transverse to the axis of partial penetration groove welds and shear in such welds, when made with A233 Class E60 series electrodes or by submerged arc welding Grade SAW-1 on all steels, or with A233 Class E70 series electrodes or by submerged arc welding Grade SAW-2 on A7 and A373 steels.....................13,600

Stress in fillet, plug, and slot welds, tension stress transverse to the axis of partial penetration groove welds and shear in such welds, when made with A233 Class E70 series electrodes or by submerged arc welding Grade SAW-2 on A36, A242 and A441 steels...............................15,800

1.5.3.2. Groove Welds.

The full stresses allowed by Sect. 1.5A for the connected material shall apply to complete penetration groove welds stressed in tension, compression, bending, shear and bearing and to partial penetration groove welds stressed in compression, in bearing or in tension parallel to the axis of the weld. (See Sect. 1.17.2 for electrodes and submerged arc welding process to be employed on various grades of steel.)

1.5.4. Cast Steel and Steel Forgings. — Allowable stresses same as those provided in Sect. 1.5.1, where applicable.

1.5.5A. Masonry Bearing. — Refer to Parts 24 and 26 of this Code.

1.5.6. Wind and Seismic Stresses. — Allowable stresses may be increased one-third above the values provided in Sect. 28–1.5.1, 28–1.5.2A, 28–1.5.3, 28–1.5.4 and 28–1.5.5A when produced by wind or seismic loading, acting alone or in combination with the design dead and live loads, provided the required section computed on this basis is not less than that required for the design dead and live load and impact (if any), computed without the one-third stress increase, nor less than that required by Sect. 28–1.7, if it is applicable.

Sect. 28–1.6A. Combined Stresses.

1.6.1A. Axial Compression and Bending. — Members subject to both axial compression and bending stresses shall be proportioned to meet the following requirements:

If $f_a/F_a \leq 0.15$,

it is required: $$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0 \qquad \text{Formula (6)}$$

If $f_a/F_a > 0.15$,

it is required: $$\frac{f_a}{F_a} + \frac{C_m f_b}{\left(1 - \frac{f_a}{F'_e}\right) F_b} \leq 1.0 \qquad \text{Formula (7a)}$$

provided, however, that if there are points braced in the plane of bending, it is also required:

$$\frac{f_a}{0.6F_y} + \frac{f_b}{F_b} \leq 1.0 \qquad \text{Formula (7b)}$$

The nomenclature in the preceding provisions of this subdivision 1.6.1A shall be construed as follows:

F_a = axial stress that would be permitted if axial force alone existed

F_b = compressive bending stress that would be permitted if bending moment alone existed

$$F'_e = \frac{149{,}000{,}000}{\left(\frac{Kl_b}{r_b}\right)^2}$$

(In the expression for F'_e, l_b is the actual unbraced length *in the plane of bending* and r_b is the corresponding radius of gyration. K is the effective length factor *in the plane of bending*. As in the case of F_a, F_b and $0.6F_y$ as used in Formula (7b), F'_e may be increased one-third in accordance with Sect. 28–1.5.6.)

C_m = a coefficient whose value shall be as follows:

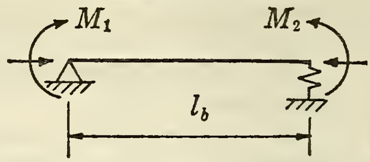
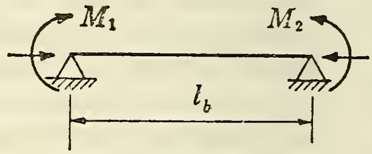
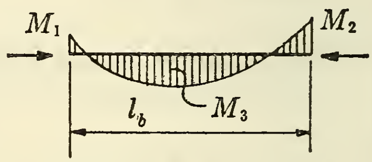
A. For compressoin members in frames subject to joint translation (sidesway), $C_m = 0.85$.

B. For restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports in the plane of bending, $C_m = 0.6 + 0.4 \dfrac{M_1}{M_2}$, but not less than 0.4, where M_1/M_2 is the ratio of the smaller to the larger moments at the ends of that portion of the member, unbraced in the plane of bending, under consideration. M_1/M_2 is positive when the member is bent in single curvature and negative when it is bent in reverse curvature.

C. For compression members in frames braced against joint translation in the plane of loading and subjected to transverse loading between their supports, the value of C_m may be determined by rational analysis. However, in lieu of such analysis, the following values may be used: (a) for members whose ends are restrained, $C_m = 0.85$, (b) for members whose ends are unrestrained, $C_m = 1$.

Values of C_m for Categories A, B, and C are shown in Table C 1.6.1.1.

Table C 1.6.1.1

Category	Loading conditions ($f_a > 0.15F_a$)	f_b	C_m	Remarks
A	Computed moments maximum at end; joint translation not prevented	$\frac{M_2}{S}$	0.85	 $M_1 < M_2$; $\frac{M_1}{M_2}$ positive as shown Check Formulas (7a) & (7b)
B	Computed moments maximum at end; no transverse loading; joint translation prevented	$\frac{M_2}{S}$	$\left(0.4 \frac{M_1}{M_2} + 0.6\right)$ but not less than 0.4	 Check both Formulas (7a) & (7b)
C	Transverse loading; joint translation prevented	$\frac{M_2}{S}$ Using Formula (7b) $\frac{M_3}{S}$ Using Formula (7a)	$1 + \psi \frac{f_a}{F'_e}$	 Check both Formulas (7a) & (7b)

When bending occurs simultaneously about both axes of a column the second (bending) term in Formula (7a) shall be evaluated as the sum of two terms, as

$$\frac{C_m f_b}{\left(1 - \frac{f_a}{F'_e}\right) F_b} = \frac{C_{mx} f_{bx}}{\left(1 - \frac{f_a}{F'_{ex}}\right) F_{bx}} + \frac{C_{my} f_{by}}{\left(1 - \frac{f_a}{F'_{ey}}\right) F_{by}}$$

where the subscripts x and y refer to the principal axes of bending of the column profile.

Category (C) is exemplified by the compression chord of a truss, subject to transverse loading between panel points. For this case the value for C_m can be computed using the expression

$$C_m = 1 + \psi \frac{f_a}{F'_e}$$

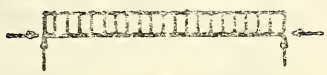
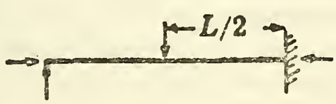
where

$$\psi = \frac{\pi^2 \delta_0 EI}{M_0 l^2_b} - 1$$

δ_0 = maximum deflection due to transverse loading
M_0 = maximum moment between supports due to transverse loading

Values for ψ for several conditions of loading and end restraint shall be determined in accordance with the following Table C 1.6.1.2.

Table C 1.6.1.2

Case	ψ	C_m
	0	1.0
	−0.3	$1 - .3 \frac{f_a}{F'_e}$
	−0.4	$1 - .4 \frac{f_a}{F'_e}$
	−0.2	$1 - .2 \frac{f_a}{F'_e}$
	−0.4	$1 - .4 \frac{f_a}{F'_e}$
	−0.6	$1 - .6 \frac{f_a}{F'_e}$

1.6.2A. Axial Tension and Bending. — Members subject to both axial tension and bending stresses shall be proportioned to satisfy the requirement of Formula (7b) where f_b and F_b are taken, respectively, as the computed and permitted bending tensile stress. However, the computed bending compressive stress, taken alone, shall not exceed the value permitted by Formulas (4), (5A) or (5B).

1.6.3A. Shear and Tension. — Rivets and bolts subject to combined shear and tension due to force applied to the connected parts, shall be so proportioned that the tension stress produced by the force shall not exceed the following:

For A141 rivets.................... $F_t = 28{,}000 - 1.6f_v \leq 20{,}000$
For A195 and A406 rivets.......... $F_t = 38{,}000 - 1.6f_v \leq 27{,}000$
For A307 bolts.................... $F_t = 20{,}000 - 1.6f_v \leq 14{,}000$
For A325 bolts in bearing-type joints $F_t = 37{,}500 - 1.6f_v \leq 30{,}000$
For A354, Grade BC, bolts in
bearing-type joints.............. $F_t = 45{,}000 - 1.6f_v \leq 37{,}500$

where f_v, the shear stress produced by the same force, shall not exceed the value for shear given in Sect. 28–1.5.2A.

For bolts used in friction-type joints, the shear stress allowed in Sect. 28–1.5.2A shall be reduced so that:

For A325 bolts........................ $F_v \leq 15{,}000(1 - f_tA_b/T_b)$
For A354, Grade BC, bolts............ $F_v \leq 20{,}000(1 - f_tA_b/T_b)$

where f_t is the tensile stress due to applied load and T_b is the proof load of the bolt.

Sect. 28–1.7. Members and Connections Subject to Repeated Variation of Stress.

1.7.1. Up to 10,000 Complete Stress Reversals. — The stress-carrying area of members, connection material and fasteners* need not be increased because of repeated variation or reversal of stress unless the maximum stress allowed by Sect. 28–1.5 and 28–1.6 is expected to occur over 10,000† times in the life of the structure.

1.7.2. 10,000 to 100,000 Cycles of Maximum Load. — Members, connection material and fasteners (except high strength bolts in friction-type joints) subject to more than 10,000 but not over 100,000‡ applications of maximum design loading shall be proportioned, at unit stresses allowed in Sect. 28–1.5 and 28–1.6 for the kind of steel and fasteners used, to support the algebraic difference§ of the maximum computed stress and two-thirds of the minimum computed stress, but the stress-carrying area shall not be less than that required in proportioning the member, connection material and fasteners to support either the maximum or minimum computed stress at the values allowed in Sect. 28–1.5 and 28–1.6 for the kind of steel and fasteners used.

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* As used in this Section, "fasteners" comprise welds, rivets and bolts.
† Approximately equivalent to one application per day for 25 years.
‡ Approximately equivalent to ten applications per day for 25 years.
§ In determining the algebraic difference, tensile stress is designated as positive and compression stress as negative.

1.7.3. 100,000 to 2,000,000 Cycles of Maximum Load. — Members, connection material and fasteners (except high strength bolts in friction-type joints) subject to more than 100,000 but not more than 2,000,000¶ applications of maximum design loading shall be proportioned at unit stresses allowed in Sect. 28–1.5 and 28–1.6 for A7 steel, A141 rivet steel and E60XX and submerged arc Grade SAW-1 welds to support the algebraic difference of the maximum computed stress and ⅔ of the minimum computed stress, but the stress-carrying area shall not be less than that required in proportioning the member, connection material and fasteners to support either the maximum or minjmum computed stress at the values allowed in Sect. 28–1.5 and 28–1.6 for the kind of steel and fasteners used.

1.7.4. Over 2,000,000 Cycles of Maximum Load. — Members, connection material and fasteners (except high strength bolts in friction-type joints) subject to more than 2,000,000 applications of maximum design loading shall be proportioned at two-thirds of the unit stress allowed in Sect. 28–1.5 and 28–1.6 for A7 steel, A141 rivet steel and E60XX and submerged arc Grade SAW-1 welds to support the algebraic difference of the maximum computed stress and three-quarters of the minimum computed stress, but the stress-carrying area shall not be less than that required in proportioning the member, connection material and fastener to support either the maximum or minimum computed stress at the values allowed in Sect. 28–1.5 and 28–1.6 for the kind of steel and fasteners used.

1.7.5. Details. — Members subject to the provisions of Sect. 28–1.7.2, 28–1.7.3 and 28–1.7.4 shall have no sharp notches, sharp copes or attachments of clips, brackets or similar details, at locations where the stress exceeds 75 percent of those allowed in this section.

1.7.6. High Strength Bolted Connections. — High strength bolts in friction-type joints shall be proportioned at the unit stresses allowed in Sect. 28–1.5.2 and 28–1.6.2 to resist the largest stress on the joint produced by any single application of the design loads.

Sect. 28–1.8A. Slenderness Ratios.

1.8.1A. Definition.

In determining the slenderness ratio of an axially loaded compression member, except as provided in Sect. 28–1.5.1.3.3A, the length shall be taken as its effective length Kl, and r as the corresponding radius of gyration.

1.8.2A. Sidesway Prevented. — In frames where lateral stability is provided by diagonal bracing, shear walls, attachment to an adjacent structure having adequate lateral stability, or by floor slabs or roof decks secured horizontally by walls or bracing systems parallel to the plane of the frame, and in trusses, the effective length factor K for the compression members shall be taken as unity, except as otherwise permitted in Sect. 28–1.8.3A.

¶ Approximately equivalent to 200 applications per day for 25 years.

1.8.3A. Determination of Effective Length. — The effective length Kl of compression members in a frame which depends upon its own bending stiffness for lateral stability, shall be determined by a rational method and shall not be less than the actual unbraced length.

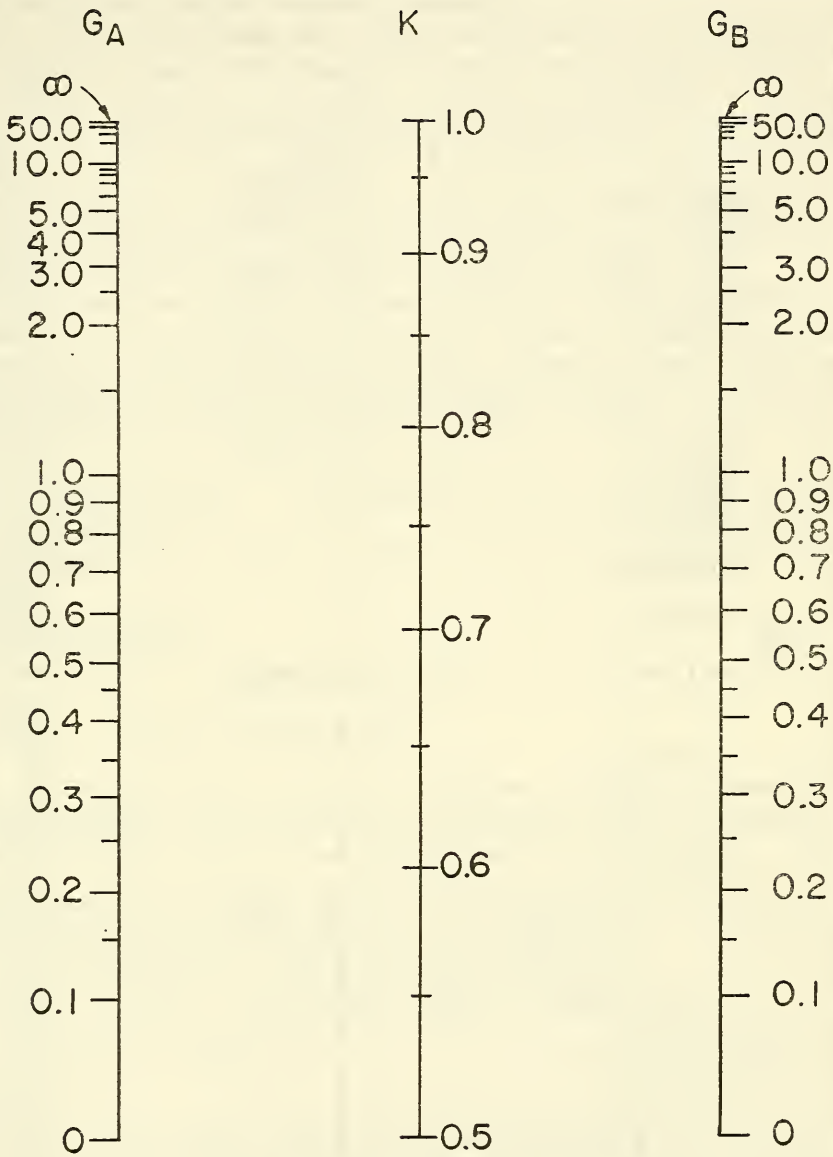
Figs. 1 and 2 may be used to determine the effective length factor K which depends upon the end restraints and which when multiplied by the actual length gives the effective length for use in Formulas (1) and (2).

Figure 1 *may* be used in case effective means to prevent sidesway of the column are employed. Figure 2 *shall* be used in case sidesway is possible. In figures 1 and 2 the subscripts A and B refer to the joints at the two ends of the column section being considered. G is given by

$$G = \frac{\sum \frac{I_c}{L_c}}{\sum \frac{I_g}{L_g}}$$

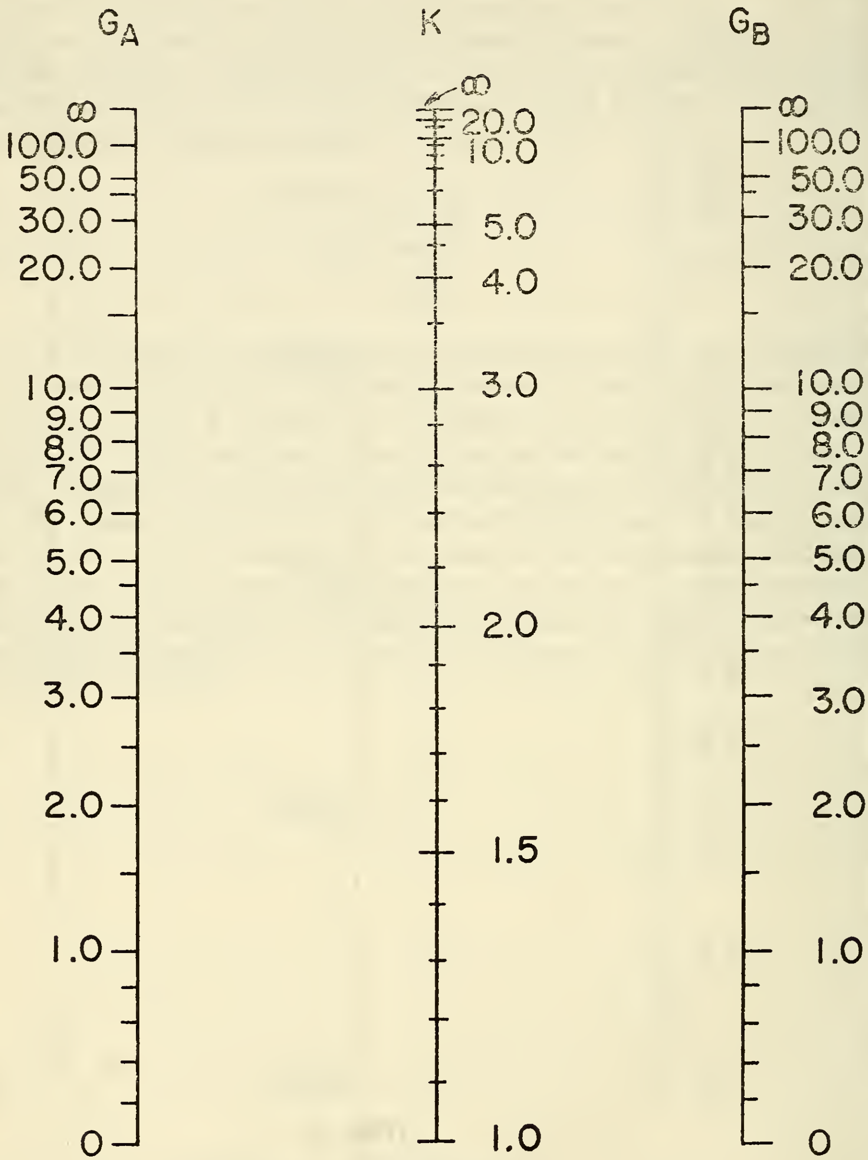
in which $\sum$ indicates a summation for all members, other than those the principal function of which is to resist tensile axial forces, rigidly connected to that joint as in Class A construction and lying in the plane in which buckling of the column is being considered, I_c is the moment of inertia and L_c the unsupported length of column section, and I_g is the moment of inertia and L_g the unsupported length of a girder or other restraining member. I_c and I_g shall be taken about axes perpendicular to the plane of buckling being considered.

In Figures 1 and 2, having determined G_A and G_B for a column section, K is obtained by constructing a straight line between the appropriate points on the scales for G_A and G_B. For example, in Figure 1, if G_A is 0.5 and G_B is 1.0, K is found to be 0.73.



(FIG. 1)

Sidesway Prevented



(FIG. 2)

Sidesway Permitted

In case Class C "semi-rigid framing" is employed the values of $\frac{I_g}{L_g}$ shall be decreased sufficiently to fully reflect the effect of changes in angle between columns and girders or other restraining members.

For the case in which sidesway is permitted and the far end of a girder or other restraining member with respect to a given column is free to rotate in the plane of the frame (virtually hinged) the value of $\frac{I_g}{L_g}$ shall be reduced by 50 percent.

Refinements in the value of $\frac{I_g}{L_g}$ and K may be made provided they are fully substantiated by analysis supplemented if necessary by tests

For column ends supported by but not rigidly connected to a footing or foundation, G may be taken as 10 unless the support is designed as a true friction-free pin in which case G shall be taken as infinity. If the column end is rigidly attached to a properly designed footing, G may be taken as 1.0. Smaller values may be used if justified by analysis.

1.8.4. Maximum Ratios. — The slenderness ratio of compression members shall not exceed 200.

The slenderness ratio of tension members, other than rods, preferably should not exceed:

For main members	240
For bracing and other secondary members	300

Sect. 28–1.9. Width-Thickness Ratios.

1.9.1. Projecting Elements Under Compression. — Projecting elements of members subjected to axial compression or compression due to bending shall have ratios of width-to-thickness not greater than the following:

Single-angle struts; double-angle struts with separators	$2{,}400/\sqrt{F_y}$
Struts comprising double angles in contact; angles or plates projecting from girders, columns or other compression members; compression flanges of beams; stiffeners on plate girders	$3{,}000/\sqrt{F_y}$
Stems of tees	$4{,}000/\sqrt{F_y}$

The width of plates shall be taken from the free edge to the first row of rivets, bolts or welds; the width of legs of angles, channels and zees, and of the stems of tees, shall be taken as the full nominal dimension the width of flanges of beams and tees shall be taken as one-half the full nominal width. The thickness of a sloping flange shall be measured halfway between a free edge and the corresponding face of the web.

When a projecting element exceeds the width-to-thickness ratio prescribed in the preceding paragraph, but would conform to same and would satisfy the stress requirements with a portion of its width considered as removed, the member will be acceptable.

1.9.2. Compression Elements Supported Along Two Edges. — In compression members the unsupported width of web, cover or diaphragm plates between the nearest lines of fasteners or welds, or between the roots of the flanges in case of rolled sections, shall not exceed $8{,}000/\sqrt{F_y}$ times its thickness.

When the unsupported width exceeds this limit, but a portion of its width no greater than $8{,}000/\sqrt{F_y}$ times the thickness would satisfy the stress requirements, the member will be considered acceptable.

The unsupported width of cover plates perforated with a succession of access holes, may exceed $8{,}000/\sqrt{F_y}$, but shall not exceed $10{,}000/\sqrt{F_y}$, times the thickness. The gross width of the plate less the width of the widest access hole shall be assumed available to resist compression.

Sect. 28–1.10. Plate Girders and Rolled Beams.

1.10.1. Proportions. — Riveted and welded plate girders, cover-plated beams and rolled beams shall in general be proportioned by the moment of inertia of the gross section. No deduction shall be made for shop or field rivet or bolt holes in either flange, except that in cases where the reduction of the area of either flange by such holes, calculated in accordance with the provisions of Sect. 28–1.14.3 exceeds 15 percent of the gross flange area, the excess shall be deducted.

1.10.2. Web. — The clear distance between flanges in inches, shall not exceed

$$\frac{14{,}000{,}000}{\sqrt{F_y\,(F_y + 16{,}500)}}$$

times the web thickness.

1.10.3. Flanges. — The thickness of outstanding parts of flanges shall conform to the requirements of Sect. 28–1.9.

Each flange of welded plate girders shall in general consist of a single plate rather than two or more plates superimposed. The single plate may comprise a series of shorter plates, laid end-to-end and joined by complete penetration butt welds.

Unstiffened cover plates on riveted girders shall not extend more than $3{,}000/\sqrt{F_y}$ times the thickness of the thinnest outside plate beyond the outer row of rivets or bolts connecting them to the angles. The total cross-sectional area of cover plates of riveted girders shall not exceed 70 percent of the total flange area.

1.10.4. Flange Development. — Rivets, high strength bolts or welds connecting flange to web, or cover plate to flange, shall be proportioned to resist the total horizontal shear resulting from the bending forces on the girder. The longitudinal distribution of these rivets, bolts or of intermittent welds shall be in proportion to the intensity of the shear. But the longitudinal spacing shall not exceed the maximum permitted, respectively, for compression or tension members in Sect. 28–1.18.2.3 or 28–1.18.3.1. Additionally, rivets

or welds connecting flange to web shall be proportioned to transmit to the web any loads applied directly to the flange unless provision is made to transmit such loads by direct bearing.

Partial length cover plates shall be extended beyond the theoretical cut-off point and the extended portion shall be attached to the beam or girder by rivets, high strength bolts (friction-type joint), or fillet welds adequate, at stresses allowed in Sect. 28–1.5.2A or 28–1.5.3 or Sect. 28–1.7, to develop the cover plate's portion of the flexural stresses in the beam or girder at the theoretical cut-off point. In addition, for welded cover plates, the welds connecting the cover plate termination to the beam or girder in the length a', defined below, shall be adequate, at the allowed stresses, to develop the cover plate's portion of the flexural stresses in the beam or girder at the distance a' from the end of the cover plate.* The length a', measured from the end of the cover plate, shall be:

1. A distance equal to the width of the cover plate when there is a continuous weld equal to or larger than ¾ of the plate thickness across the end of the plate and continued welds along both edges of the cover plate in the length a'.

2. A distance equal to 1½ times the width of the cover plate when there is a continuous weld smaller than ¾ of the plate thickness across the end of the plate and continued welds along both edges of the cover plate in the length a'.

3. A distance equal to 2 times the width of the cover plate when there is no weld across the end of the plate but continuous welds along both edges of the cover plate in the length a'.

1.10.5. Stiffeners.

1.10.5.1. — Bearing stiffeners shall be placed in pairs at unframed ends on the webs of plate girders and, where required,† at points of concentrated loads. Such stiffeners shall have a close bearing against the flange, or flanges, through which they receive their loads or reactions, and shall extend approximately to the edge of the flange plates or flange angles. They shall be designed as columns subject to the provisions of Sect. 28–1.5.1, assuming the column section to comprise the pair of stiffeners and a centrally located strip of the web whose width is equal to not more than 25 times its thickness at interior stiffeners or a width equal to not more than 12 times its thickness when the stiffeners are located at the end of the web. The effective length shall be taken as not less than ¾ of the length of the stiffeners in computing the ratio l/r. Only that portion of the stiffener outside of the angle fillet or the flange-to-web welds shall be considered effective in bearing.

1.10.5.2. — The largest average web shear f_v in any panel between stiffeners (total shear force divided by web cross-sectional area), in pounds per square

* This may require the cover plate termination to be placed at a point in the beam or girder that has lower bending stress than the stress at the theoretical cut-off point.

† For provisions governing welded plate girders see Sect. 28–1.10.10.

inch, computed for any condition of complete or partial loading, shall not exceed the value given by Formula (8) or (9), as applicable.

$$F_v = \frac{F_y}{2.89}\left[C_v + \frac{1 - C_v}{1.15\sqrt{1 + (a/h)^2}}\right] \qquad \text{Formula (8)}$$

when C_v is less than 1.0;

$$F_v = \frac{F_y}{2.89}(C_v) \qquad \text{Formula (9)}$$

but not more than $0.4F_y$, when C_v is more than 1.0 or when intermediate stiffeners are omitted;

where

a = clear distance between transverse stiffeners, in inches
h = clear distance between flanges, in inches

$$C_v = \frac{45{,}000{,}000k}{F_y(h/t)^2}, \text{ when } C_v \text{ is less than 0.8}$$

$$= \frac{6{,}000}{h/t}\sqrt{\frac{k}{F_y}}, \text{ when } C_v \text{ is more than 0.8}$$

t = thickness of web, in inches

$$k = 4.00 + \frac{5.34}{(a/h)^2}, \text{ when } a/h \text{ is less than 1.0}$$

$$= 5.34 + \frac{4.00}{(a/h)^2}, \text{ when } a/h \text{ is more than 1.0}$$

When a/h is more than 3 its value shall be taken as infinity. In this case Formula (8) reduces to Formula (9) and $k = 5.34$.

1.10.5.3. — Intermediate stiffeners are not required when the ratio h/t is less than 260 and the maximum web shear stress f_v is less than that permitted by Formula (9).

The spacing of intermediate stiffeners, when stiffeners are required, shall be such that the web shear stress will not exceed the value for F_v given by Formulas (8) or (9), as applicable, and the ratio a/h shall not exceed $\left(\frac{260}{h/t}\right)^2$ nor 3.0.

The spacing between stiffeners at end panels and panels containing large holes shall be such that the smaller panel dimension, a or h, shall not exceed $\frac{11{,}000t}{\sqrt{f_v}}$.

1.10.5.4. — The gross area, in square inches, of intermediate stiffeners spaced in accordance with Formula (8) (total area, when stiffeners are furnished in pairs) shall be not less than that computed by Formula (10).

$$A_{st} = \frac{1 - C_v}{2}\left[\frac{a}{h} - \frac{(a/h)^2}{\sqrt{1 + (a/h)^2}}\right] YDht \qquad \text{Formula (10)}$$

where

C_v, a, h and t are as defined in Sect. 28–1.10.5.2

$$Y = \frac{\text{yield point of web steel}}{\text{yield point of stiffener steel}}$$

D = 1.0 for stiffeners furnished in pairs
= 1.8 for single angle stiffeners
= 2.4 for single plate stiffeners

When the greatest shear stress f_v in a panel is less than that permitted by Formula (8) this gross area requirement may be reduced in like proportion.

The moment of inertia of a pair of stiffeners, or a single stiffener, with reference to an axis in the plane of the web, shall not be less than $(h/50)^4$.

Intermediate stiffeners may be stopped short of the tension flange a distance not to exceed 4 times the web thickness, provided bearing is not needed to transmit a concentrated load or reaction. When single stiffeners are used they shall be attached to the compression flange, if it consists of a rectangular plate, to resist any uplift tendency due to torsion in the plate. When lateral bracing is attached to a stiffener, or a pair of stiffeners, these, in turn, shall be connected to the compression flange to transmit 1 percent of the total flange stress, unless the flange is composed only of angles.

Intermediate stiffeners required by the provisions of Sect. 28–1.10.5.3 shall be connected for a total shear transfer, in pounds per linear inch of single stiffener or pair of stiffeners, not less than that computed by the formula

$$f_{vs} = h\sqrt{\left(\frac{F_y}{3,400}\right)^3}$$

where F_y = yield point of web steel.

This shear transfer may be reduced in the same proportion that the largest computed shear stress f_v in the adjacent panels is less than that permitted by Formula (8). However, rivets and welds in intermediate stiffeners which are required to transmit to the web an applied concentrated load or reaction shall be proportioned for not less than the applied load or reaction.

Rivets connecting stiffeners to the girder web shall be spaced not more than 12 inches on center. If intermittent fillet welds are used, the clear distance between welds shall not be more than 16 times the web thickness nor more than 10 inches.

1.10.6. Reduction in Flange Stress. — When the web depth-to-thickness ratio exceeds $24,000/\sqrt{F_b}$, the maximum stress in the compression flange shall not exceed

$$F'_b \leq F_b\left[1.0 - 0.0005\frac{A_w}{A_f}\left(\frac{h}{t} - \frac{24,000}{\sqrt{F_b}}\right)\right] \qquad \text{Formula (11)}$$

where

F_b = applicable bending stress given in Sect. 28–1.5.1
A_w = area of the web
A_f = area of compression flange

1.10.7. Combined Shear and Tension Stress. — Plate girder webs subject to a computed average shear stress in excess of that permitted by Formula (9) shall be so proportioned that bending tensile stress, due to moment in the plane of the girder web, shall not exceed 0.6 F_y nor

$$\left(0.825 - 0.375\frac{f_v}{F_v}\right)F_y \qquad \text{Formula (12)}$$

where

f_v = computed web shear stress (total shear divided by web area)
F_v = allowable web shear stress according to Formula (8) or (9)

1.10.8. Splices. — Butt welded splices in plate girders and beams shall be complete penetration groove welds and shall develop the full strength of the smaller spliced section. Other types of splices in cross-sections of plate girders and in beams, shall develop the strength required by the stresses, at the point of splice, but in no case less than 50 percent of the effective strength of the material spliced.

1.10.9A. Horizontal Forces. — The flanges of plate girders supporting cranes or other moving loads shall be proportioned to resist the horizontal forces produced by such loads. (See Part 23)

1.10.10. Web Crippling.

1.10.10.1. — Webs of beams and welded plate girders shall be so proportioned that the compressive stress at the web toe of the fillets, resulting from concentrated loads not supported by bearing stiffeners, shall not exceed the value of $0.75F_y$ pounds per square inch allowed in Sect. 28–1.5.1; otherwise, bearing stiffeners shall be provided. The governing formulas shall be:

For interior loads,

$$\frac{R}{t(N+2k)} = \text{not over } 0.75F_y \text{ pounds per square inch} \qquad \text{Formula (13)}$$

For end-reactions,

$$\frac{R}{t(N+k)} = \text{not over } 0.75F_y \text{ pounds per square inch} \qquad \text{Formula (14)}$$

where

R = concentrated load or reaction, in pounds
t = thickness of web, in inches
N = length of bearing in inches (not less than k for end reactions)
k = distance from outer face of flange to web toe of fillet, in inches

1.10.10.2. — Webs of plate girders shall also be so proportioned or stiffened that the sum of the compression stresses resulting from concentrated and distributed loads, bearing directly on or through a flange plate, upon the compression edge of the web plate, and not supported directly by bearing stiffeners, shall not exceed

$$\left[5.5 + \frac{4}{(a/h)^2}\right]\frac{10{,}000{,}000}{(h/t)^2} \text{ pounds per square inch} \qquad \text{Formula (15)}$$

when the flange is restrained against rotation, nor

$$\left[2 + \frac{4}{(a/h)^2}\right]\frac{10{,}000{,}000}{(h/t)^2} \text{ pounds per square inch} \quad \text{Formula (16)}$$

when the flange is not so restrained.

These stresses shall be computed as follows:

Concentrated loads and loads distributed over partial length of a panel shall be divided by the product of the web thickness and the girder depth or the length of panel in which the load is placed, whichever is the lesser panel dimension.

Any other distributed loading, in pounds per linear inch of length, shall be divided by the web thickness.

Sect. 28–1.11. Composite Construction.

1.11.1. Definition. — Composite construction shall consist of steel beams or girders supporting a reinforced concrete slab, so inter-connected that the beam and slab act together to resist bending. When the slab extends on both sides of the beam, the effective width of the concrete flange shall be taken as not more than one-fourth of the span of the beam, and its effective projection beyond the edge of the beam shall not be taken as more than one-half the clear distance to the adjacent beam, nor more than eight times the slab thickness. When the slab is present on only one side of the beam, the effective width of the concrete flange (projection beyond the beam) shall be taken as not more than one-twelfth of the beam span, nor six times its thickness nor one-half the clear distance to the adjacent beam.

Beams totally encased 2 inches or more on their sides and soffit in concrete poured integrally with the slab may be assumed to be interconnected to the concrete by natural bond, without additional anchorage, provided the top of the beam is at least 1½ inches below the top and 2 inches above the bottom of the slab, and provided that the encasement has adequate mesh or other reinforcing steel throughout the whole depth and across the soffit of the beam. When shear connectors are provided in accordance with Sect. 28–1.11.4, encasement of the beam to achieve composite action is not required.

1.11.2. Design Assumptions.

1.11.2.1. — Encased beams shall be proportioned to support unassisted all dead loads applied prior to the hardening of the concrete (unless these loads are supported temporarily on shoring) and, acting in conjunction with the slab, to support all dead and live loads applied after hardening of the concrete, without exceeding a computed bending stress of $0.66F_y$, where F_y is the yield point of the steel beam. The bending stress produced by loads after the concrete has hardened shall be computed on the basis of the moment of inertia of the composite section. Concrete tension stresses below the neutral axis of the composite section shall be neglected. Alternatively, the steel beam alone

may be proportioned to resist unassisted the moment produced by all loads, live and dead, using a bending stress equal to $0.76F_y$, in which case temporary shoring is not required.

1.11.2.2. — When shear connectors are used in accordance with Sect. 28–1.11.4 the composite section shall be proportioned to support all of the loads without exceeding the allowable stress prescribed in Sect. 28–1.5.1.4.1 or 28–1.5.1.4.4, as applicable. The moment of inertia I_{tr} of the composite section shall be computed in accordance with the elastic theory. Concrete tension stresses below the neutral axis of the composite section shall be neglected. The compression area of the concrete above the neutral axis shall be treated as an equivalent area of steel by dividing it by the modular ratio n.

For construction without temporary shoring the value of the section modulus of the transformed composite section used in stress calculations (referred to the tension flange) shall not exceed

$$S_{tr} = \left(1.35 + 0.35\,\frac{M_L}{M_D}\right) S_s \qquad \text{Formula (17)}$$

where M_L and M_D are, respectively, the live load and dead load moments and S_s is the section modulus of the steel beam (referred to its tension flange) and provided that the steel beam alone, supporting the loads before the concrete has hardened, is not stressed to more than the applicable bending stress given in Sect. 28–1.5.1.

1.11.3. End Shear. — The web and the end connections of the steel beam shall be designed to carry the total dead and live loads.

1.11.4. Shear Connectors. — Except in the case of encased beams as defined in Sect. 28–1.11.1, the entire horizontal shear at the junction of the steel beam and the concrete slab shall be assumed to be transferred by shear connectors welded to the top flange of the beam and embedded in the concrete. The total horizontal shear to be thus resisted between the point of maximum positive moment and each end of the steel beam (or between the point of maximum positive moment and a point of contraflexure in continuous beams) shall be taken as the smaller value using the formulas

$$V_h = \frac{0.85 f'_c A_c}{2} \qquad \text{Formula (18)}$$

and

$$V_h = \frac{A_s F_y}{2} \qquad \text{Formula (19)}$$

where

f'_c = specified compression strength of concrete at 28 days
A_c = actual area of effective concrete flange defined in Sect. 28–1.11.1
A_s = area of steel beam

The number of connectors resisting this shear, each side of the point of maximum moment, shall not be less than that determined by the relationship V_h/q, where q, the allowable shear load for one connector, or one pitch of a spiral bar, is as given in Table 28–1.11.4.

Table 28–1.11.4

Connector	Allowable Horizontal Shear Load (q) (kips) (Applicable only to concrete made with ASTM C33-61T aggregate)		
	$f'_c = 3{,}000$	$f'_c = 3{,}500$	$f'_c = 4{,}000$
½″ diam. × 2″ hooked or headed stud	5.1	5.5	5.9
⅝″ diam. × 2½″ hooked or headed stud	8.0	8.6	9.2
¾″ diam. × 3″ hooked or headed stud	11.5	12.5	13.3
⅞″ diam. × 3½″ hooked or headed stud	15.6	16.8	18.0
3″ channel, 4.1 lb.	$4.3w$	$4.7w$	$5.0w$
4″ channel, 5.4 lb.	$4.6w$	$5.0w$	$5.3w$
5″ channel, 6.7 lb.	$4.9w$	$5.3w$	$5.6w$
½″ diam. spiral bar	11.9	12.4	12.8
⅝″ diam. spiral bar	14.8	15.4	15.9
¾″ diam. spiral bar	17.8	18.5	19.1

w = length of channel in inches.

The required number of shear connectors may be spaced uniformly between the sections of maximum and zero moment.

Shear connectors shall have at least 1 inch of concrete cover in all directions.

Sect. 28–1.12A. Simple and Continuous Spans.

1.12.1A. Simple Spans. — When beams, girders and trusses are designed on the basis of simple spans, the effective length shall be taken as the distance between centers of gravity of the members to which they deliver their end reactions.

1.12.2. End Restraint. — When designed on the assumption of full or partial end restraint, due to continuous, semi-continuous or cantilever action, the beams, girders and trusses, as well as the sections of the members to which they connect, shall be designed to carry the shears and moments so introduced, as well as all other forces, without exceeding at any point the unit stresses prescribed in Sect. 28–1.5.1 except that some non-elastic but self-limiting deformation of a part of the connection may be permitted when this is essential to the avoidance of overstressing of fasteners.

Sect. 28–1.13. Deflections. — Beams and girders supporting floors and roofs shall be proportioned with due regard to the deflection produced by the design loads.

Beams and girders supporting plastered ceilings shall be so proportioned that the maximum live load deflection will not exceed 1/360 of the span.

The depth of beams and girders supporting flat roofs shall be not less than f_b/600,000 times their span length whether designed as simple or continuous spans.

Sect. 28–1.14. Gross and Net Sections.

1.14.1. Definitions. — The gross section of a member at any point shall be determined by summing the products of the thickness and the gross width of each element as measured normal to the axis of the member. The net section shall be determined by substituting for the gross width the net width computed in accordance with Sect. 28–1.14.3 to 28–1.14.6 inclusive.

1.14.2. Application. — Unless otherwise specified, tension members shall be designed on the basis of net section. Compression members shall be designed on the basis of gross section. Beams and girders shall be designed in accordance with Sect. 28–1.10.1.

1.14.3. Net Section. — In the case of a chain of holes extending across a part in any diagonal or zigzag line, the net width of the part shall be obtained by deducting from the gross width the sum of the diameters of all the holes in the chain, and adding, for each gage space in the chain, the quantity

$$\frac{s^2}{4g}$$

where

s = longitudinal spacing (pitch, in inches) of any two consecutive holes
g = transverse spacing (gage, in inches) of the same two holes

The critical net section of the part is obtained from that chain which gives the least net width; however, the net section taken through a hole shall in no case be considered as more than 85 percent of the corresponding gross section.

In determining the net section across plug or slot welds, the weld metal shall not be considered as adding to the net area.

1.14.4. Angles. — For angles, the gross width shall be the sum of the width of the legs less the thickness. The gage for holes in opposite legs shall be the sum of the gages from back of angles less the thickness.

1.14.5. Size of Holes. — In computing net area the diameter of a rivet or bolt hole shall be taken as ⅛ inch greater than the nominal diameter of the rivet or bolt.

1.14.6. Pin-Connected Members. — Eyebars shall be of uniform thickness without reinforcement at the pin holes.* They shall have "circular" heads in which the periphery of the head beyond the pin hole is concentric with the pin hole. The radius of transition between the circular head and the body of the eyebar shall be equal to or greater than the diameter of the head.

The width of the body of the eyebar shall not exceed 8 times its thickness, and the thickness shall not be less than ½ inch. The net section of the head through the pin hole transverse to the axis of the eyebar, shall not be less than 1.33 nor more than 1.50 times the cross-sectional area of the body of the

* Members having a different thickness at the pin hole location are termed "built-up."

eyebar. The diameter of the pin shall not be less than ⅞ the width of the body of the eyebar. The diameter of the pin hole shall not be more than 1/32 inch greater than the diameter of the pin.

The minimum net section across the pin hole, transverse to the axis of the member, in pin-connected plates and built-up members shall be determined at the stress allowed for such sections in Sect. 28–1.5.1.1. The net section beyond the pin hole, parallel to the axis of the member, shall not be less than ⅔ of the net section across the pin hole. The corners beyond the pin hole may be cut at 45° to the axis of the member provided the net section beyond the pin hole on a plane perpendicular to the cut is not less than that required beyond the pin hole parallel to the axis of the member. The parts of members built up at the pin hole shall be attached to each other by sufficient fasteners to support the stress delivered to them by the pin.

The distance transverse to the axis of a pin-connected plate or any separated element of a built-up member from the edge of the pin hole to the edge of the member or element, shall not exceed 4 times the thickness at the pin hole. The diameter of the pin shall preferably not be less than 5 times the thickness of the member or separated element at the pin hole. If a smaller size is used, the bearing stress shall not exceed that allowed by Sect. 28–1.5.1.5.1. The diameter of the pin hole shall not be more than 1/32 inch greater than the diameter of the pin.

1.14.7. Effective Areas of Weld Metal. — The effective area of butt and fillet welds shall be considered as the effective length of the weld times the effective throat thickness.

The effective shearing area of plug and slot welds shall be considered as the nominal cross-sectional area of the hole or slot, in the plane of the faying surface.

The effective area of fillet welds in holes and slots shall be computed as above specified for fillet welds, using for effective length, the length of center-line of the weld through the center of the plane through the throat. However, in the case of overlapping fillets, the effective area shall not exceed the nominal cross-sectional area of the hole or slot, in the plane of the faying surface.

The effective length of a fillet weld shall be the overall length of full-size fillet including returns.

The effective length of a butt weld shall be the width of the part joined.

The effective throat thickness of a fillet weld shall be the shortest distance from the root to the face of the diagrammatic weld.

The effective throat thickness of a complete penetration butt weld (i.e., a butt weld conforming to the requirements of Sect. 28–1.23.6) shall be the thickness of the thinner part joined.

The effective throat thickness of single-V or single-bevel groove welds having no root opening and having partial penetration into their joints shall be ¼ inch less than the depth of the V or bevel groove. The effective throat thickness of single-J or single-U groove welds having no root opening and having partial penetration into their joints shall be the depth of the J or U groove. The

effective throat thickness of any of these partial penetration groove welds shall be not less than $\sqrt{t_t/6}$, where t_t is the thickness of the thinner part connected by the weld.

Sect. 28–1.15. Connections.

1.15.1. Minimum Connections. — Connections carrying calculated stresses, except for lacing, sag bars, and girts, shall be designed to support not less than 6,000 pounds.

1.15.2. Eccentric Connections. — Axially stressed members meeting at a point shall have their gravity axes intersect at a point if practicable; if not, provision shall be made for bending stresses due to the eccentricity.

1.15.3. Placement of Rivets, Bolts and Welds. — Except as hereinafter provided, the rivets, bolts or welds at the ends of any member transmitting axial stress into that member shall have their centers of gravity on the gravity axis of the member unless provision is made for the effect of the resulting eccentricity. Except in members subject to repeated variation in stress, as defined in Sect. 28–1.7, disposition of fillet welds to balance the forces about the neutral axis or axes for end connections of single angle, double angle, and similar type members is not required. Eccentricity between the gravity axes of such members and the gage lines for their riveted or bolted end connections may be neglected.

1.15.4. Unrestrained Members. — Except as otherwise indicated by the designer, connections of beams, girders or trusses shall be designed as flexible, and may ordinarily be proportioned for the reaction shears only.

Flexible beam connections shall permit the ends of the beam to rotate sufficiently to accommodate its deflection by providing for a horizontal displacement of the top flange determined as follows:

$e = 0.007d$ when the beam is designed for full uniform load and for live load deflection not exceeding 1/360 of the span

$= \dfrac{f_b L}{3{,}600{,}000}$ when the beam is designed for full uniform load producing the unit stress f_b at mid-span

where

e = the horizontal displacement of the end of the top flange, in the direction of the span, in inches

f_b = the flexural unit stress in the beam at mid-span, in pounds per square inch

d = the depth of the beam, in inches

L = the span of the beam, in feet

1.15.5. Restrained Members. — Fasteners or welds for end connections of beams, girders and trusses not conforming to the requirements of Sect. 28–1.15.4 shall be designed for the combined effect of end reaction shear and tensile or compressive stresses resulting from moment induced by the rigidity of the connection when the member is fully loaded.

1.15.6. Fillers. — When rivets or bolts carrying computed stress pass through fillers thicker than ¼ inch, except in friction-type connections assembled with high strength bolts, the fillers shall be extended beyond the splice material and the filler extension shall be secured by enough rivets or bolts to distribute the total stress in the member uniformly over the combined section of the member and the filler, or an equivalent number of fasteners shall be included in the connection.

In welded construction, any filler ¼ inch or more in thickness shall extend beyond the edges of the splice plate and shall be welded to the part on which it is fitted with sufficient weld to transmit the splice plate stress, applied at the surface of the filler as an eccentric load. The welds joining the splice plate to the filler shall be sufficient to transmit the splice plate stress and shall be long enough to avoid overstressing the filler along the toe of the weld. Any filler less than ¼ inch thick shall have its edges made flush with the edges of the splice plate and the weld size shall be the sum of the size necessary to carry the splice plate stress plus the thickness of the filler plate.

1.15.7. Connections of Tension and Compression Members in Trusses. — The connections at ends of tension or compression members in trusses shall develop the strength required by the stress, but not less than 50 percent of the effective strength of the member. Groove welds in connections at the ends of tension or compression members in trusses shall be complete penetration groove welds.

1.15.8. Compression Members with Bearing Joints. — Where compression members bear on bearing plates, and where tier-building columns are finished to bear, there shall be sufficient rivets, bolts or welds to hold all parts securely in place.

Where other compression members are finished to bear, the splice material and its riveting, bolting or welding shall be arranged to hold all parts in line and shall be proportioned for 50 percent of the computed stress.

All of the foregoing joints shall be proportioned to resist any tension that would be developed by specified lateral forces acting in conjunction with 75 percent of the calculated dead load stress and no live load.

1.15.9. Combination of Welds. — If two or more of the general types of weld (butt, fillet, plug, slot) are combined in a single joint, the effective capacity of each shall be separately computed with reference to the axis of the group, in order to determine the allowable capacity of the combination.

1.15.10. Rivets and Bolts in Combination with Welds. — In new work, rivets, A307 bolts, or high strength bolts used in bearing-type connections, shall not be considered as sharing the stress in combination with welds. Welds, if used, shall be provided to carry the entire stress in the connection. High strength bolts installed in accordance with the provisions of Sect. 28–1.16.1A as a friction-type connection prior to welding may be considered as sharing the stress with the welds.

In making welded alterations to structures, existing rivets and properly tightened high strength bolts may be utilized for carrying stresses resulting from existing dead loads, and the welding need be adequate only to carry all additional stress.

1.15.11. High Strength Bolts (in Friction-Type Joints) in Combination with Rivets. — In new work and in making alterations, rivets and high strength bolts, installed in accordance with the provisions of Sect. 28–1.16.1A as friction-type connections, may be considered as sharing the stresses resulting from dead and live loads.

1.15.12. Field Connections. — Rivets, high strength bolts or welds shall be used for the following connections:

Column splices in all tier structures 200 feet or more in height.

Column splices in tier structures 100 to 200 feet in height, if the least horizontal dimension is less than 40 percent of the height.

Column splices in tier structures less than 100 feet in height, if the least horizontal dimension is less than 25 percent of the height.

Connections of all beams and girders to columns and of any other beams and girders on which the bracing of columns is dependent, in structures over 125 feet in height.

Roof-truss splices and connections of trusses to columns, column splices, column bracing, knee braces and crane supports, in all structures carrying cranes of over 5-ton capacity.

Connections for supports of running machinery, or of other live loads which produce impact or reversal of stress.

Any other connections stipulated on the design plans.

In all other cases field connections may be made with A307 bolts.

For the purpose of this Section, the height of a tier structure shall be taken as the vertical distance from the curb level to the highest point of the roof beams, in the case of flat roofs, or to the mean height of the gable, in the case of roofs having a rise of more than $2\frac{2}{3}$ in 12. Where the curb level has not been established, or where the structure does not adjoin a street, the mean level of the adjoining land shall be used instead of curb level. Penthouses may be excluded in computing the height of structure.

Sect. 28–1.16A. Rivets and Bolts.

1.16.1A. High Strength Bolts. — Use of high strength bolts shall conform to the provisions of the *Specifications for Structural Joints Using ASTM A325 Bolts* as approved by the Research Council on Riveted and Bolted Structural Joints, March 1962, except that A354, Grade BC, bolts meeting the dimensional requirements of the Council's specification and tightened to their proof load, may be substituted for A325 bolts at the working stresses permitted in Sects. 28–1.5A and 28–1.6A.

1.16.2. Effective Bearing Area. — The effective bearing area of rivets and bolts shall be the diameter multiplied by the length in bearing, except that for countersunk rivets and bolts half the depth of the countersink shall be deducted.

1.16.3. Long Grips. — Rivets and A307 bolts which carry calculated stress, and the grip of which exceeds five diameters, shall have their number increased 1 percent for each additional 1/16 inch in the grip.

1.16.4. Minimum Pitch. — The minimum distance between centers of rivet and bolt holes shall be not less than 2⅔ times the nominal diameter of the rivet or bolt but preferably not less than 3 diameters.

1.16.5. Minimum Edge Distance. — The minimum distance from the center of a rivet or bolt hole to any edge, used in design or in preparation of shop drawings, shall be that given in Table 28–1.16.5.

Table 28–1.16.5

Rivet or Bolt Diameter (Inches)	Minimum Edge Distance for Punched, Reamed or Drilled Holes (Inches)	
	At Sheared Edges	At Rolled Edges of Plates, Shapes or Bars or Gas Cut Edges†
½	⅞	¾
⅝	1⅛	⅞
¾	1¼	1
⅞	1½*	1⅛
1	1¾*	1¼
1⅛	2	1½
1¼	2¼	1⅝
Over 1¼	1¾ × Diameter	1¼ × Diameter

* These may be 1¼ inches at the ends of beam connection angles.
† All edge distances in this column may be reduced ⅛ inch when the hole is at a point where stress does not exceed 25 percent of the maximum allowed stress in the element.

1.16.6. Minimum Edge Distance in Line of Stress. — In bearing-type connections of tension members, where there are not more than two fasteners in a line parallel to the direction of stress, the distance from the center of the end fastener and that end of the connected part toward which the stress is directed shall be not less than

(a) for riveted connections: the area of the fastener divided by the thickness of the connected part for fasteners in single shear, and twice this distance for fasteners in double shear.

(b) for high strength bolted connections: 1½ times the distances given in (a).

The end distance may, however, be decreased in such proportion as the fastener stress is less than that permitted under Sect. 28–1.5.2A, but it shall not be less than the distance specified in Sect. 28–1.16.5 above.

When more than two fasteners are provided in the line of stress the provisions of Sect. 28–1.16.5 shall govern.

1.16.7. Maximum Edge Distance. — The maximum distance from the center of any rivet or bolt to the nearest edge of parts in contact with one another shall be 12 times the thickness of the plate, but shall not exceed 6 inches.

Sect. 28–1.17. Welds.

1.17.1. Welder and Welding Operator Qualifications. — Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in the *Standard Code for Arc and Gas Welding in Building Construction* of the American Welding Society, to perform the type of work required, except that this provision need not apply to tack welds not later incorporated into finished welds carrying calculated stress.

1.17.2. Qualifications of Weld and Joint Details. — Weld grooves for complete penetration welds which are accepted without welding procedure qualification under the *Standard Code for Welding in Building Construction* or the D1.0–63 *Standard Specification for Welded Highway and Railway Bridges* D2.0-63 of the American Welding Society may be used under this Specification without welding procedure qualification.

Weld grooves of the 60° single-V, 45° single-bevel, single-J or single-U form, conforming to the details for such grooves provided in the above AWS Standards but having partial penetration with an effective throat thickness as defined in Sect. 28–1.14.7 and no root opening, may be used under this Specification without welding procedure qualification. However, they shall not be used in butt joints to resist tensile stress acting in a direction normal to the plane of the weld throat, except in splices or connections of columns or other members subject primarily to axial compressive stress.

Joint forms or welding procedures other than those included in the foregoing may be employed provided they shall have been qualified in accordance with the requirements of these AWS Standards.

ASTM-A233 class E60 and E70* series electrodes for manual arc welding and Grade SAW-1 or Grade SAW-2* submerged arc process may be used for welding A7, A373 and A36 steel. Only E70 low-hydrogen electrodes for manual arc welding or Grade SAW-2 for submerged arc welding shall be used with A441 or weldable A242 steel, except that fillet welds or partial penetration groove welds may be made with E60 series low-hydrogen electrodes and Grade SAW-1 submerged arc process.

Welding A440 steel is not recommended.

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* See allowable stresses, Sect. 28-1.5.3.

1.17.3. Submerged Arc Welding. — The bare electrodes and granular fusible flux used in combinations for submerged arc welding shall be capable of producing weld metal having the following tensile properties when deposited in a multiple pass weld

Grade SAW-1

Tensile strength	62,000 to 80,000 psi
Yield point, min	45,000 psi
Elongation in 2 in., min	25%
Reduction in area, min	40%

Grade SAW-2

Tensile strength	70,000 to 90,000 psi
Yield point, min	50,000 psi
Elongation in 2 in., min	22%
Reduction in area, min	40%

1.17.4. Minimum Size of Fillet Welds. — In joints connected only by fillet welds, the minimum size of fillet weld to be used shall be as shown in Table 28–1.17.4 weld size is determined by the thicker of the two parts joined, except that the weld size need not exceed the thickness of the thinner part joined unless a larger size is required by calculated stress:

Table 28–1.17.4

Material Thickness of Thicker Part Joined (Inches)	Minimum Size of Fillet Weld (Inches)
To ½ inclusive	3/16
Over ½ to ¾	¼
Over ¾ to 1½	5/16
Over 1½ to 2¼	⅜
Over 2¼ to 6	½
Over 6	⅝

1.17.5. Maximum Effective Size of Fillet Welds. — The maximum size of a fillet weld that may be assumed in the design of a connection shall be such that the stresses in the adjacent base material do not exceed the values allowed in Sect. 28–1.5.1. The maximum size that may be used along edges of connected parts shall be:

1. Along edges of material less than ¼ inch thick, the maximum size may be equal to the thickness of the material.

2. Along edges of material ¼ inch or more in thickness, the maximum size shall be 1/16 inch less than the thickness of the material, unless the weld is especially designated on the drawings to be built out to obtain full throat thickness.

1.17.6. Length of Fillet Welds. — The minimum effective length of a strength fillet weld shall be not less than 4 times the nominal size, or else the size of the weld shall be considered not to exceed one-fourth of its effective length.

If longitudinal fillet welds are used alone in end connections of flat bar tension members, the length of each fillet weld shall be not less than the perpendicular distance between them. The transverse spacing of longitudinal fillet welds used in end connections shall not exceed 8 inches, unless the design otherwise prevents excessive transverse bending in the connection.

1.17.7. Intermittent Fillet Welds. — Intermittent fillet welds may be used to transfer calculated stress across a joint or faying surfaces when the strength required is less than that developed by a continuous fillet weld of the smallest permitted size, and to join components of built-up members. The effective length of any segment of intermittent fillet welding shall be not less than 4 times the weld size with a minimum of 1½ inches.

1.17.8. Lap Joints. — The minimum width of laps on lap joints shall be 5 times the thickness of the thinner part joined and not less than 1 inch. Lap joints joining plates or bars subjected to axial stress shall be fillet welded along the edge of both lapped parts except where the deflection of the lapped parts is sufficiently restrained to prevent opening of the joint under maximum loading.

1.17.9. End Returns of Fillet Welds. — Side or end fillet welds terminating at ends or sides, respectively, of parts or members shall, wherever practicable, be returned continuously around the corners for a distance not less than twice the nominal size of the weld. This provision shall apply to side and top fillet welds connecting brackets, beam seats and similar connections, on the plane about which bending moments are computed. End returns shall be indicated on the design and detail drawings.

1.17.10. Fillet Welds in Holes and Slots. — Fillet welds in holes or slots may be used to transmit shear in lap joints or to prevent the buckling or separation of lapped parts, and to join components of built-up members. Such fillet welds may overlap, subject to the provisions of Sect. 28–1.14.7. Fillet welds in holes or slots are not to be considered plug or slot welds.

1.17.11. Plug and Slot Welds. — Plug or slot welds may be used to transmit shear in a lap joint or to prevent buckling of lapped parts and to join component parts of built-up members.

The diameter of the holes for a plug weld shall be not less than the thickness of the part containing it plus 5⁄16 inch, rounded to the next greater odd 1⁄16 inch, nor greater than 2¼ times the thickness of the weld metal.

The minimum center-to-center spacing of plug welds shall be 4 times the diameter of the hole.

The length of slot for a slot weld shall not exceed 10 times the thickness of the weld. The width of the slot shall be not less than the thickness of the part containing it, plus 5⁄16 inch, rounded to the next greater odd 1⁄16 inch, nor shall it be greater than 2¼ times the thickness of the weld. The ends of the

slot shall be semicircular or shall have the corners rounded to a radius not less than the thickness of the part containing it, except those ends which extend to the edge of the part.

The minimum spacing of lines of slot welds in a direction transverse to their length shall be 4 times the width of the slot. The minimum center-to-center spacing in a longitudinal direction on any line shall be 2 times the length of the slot.

The thickness of plug or slot welds in material ⅝ inch or less in thickness shall be equal to the thickness of the material. In material over ⅝ inch in thickness, it shall be at least one-half the thickness of the material but not less than ⅝ inch.

Sect. 28–1.18. Built-Up Members.

1.18.1. Open Box-Type Beams and Grillages. — Where two or more rolled beams or channels are used side-by-side to form a flexural member, they shall be connected together at intervals of not more than 5 feet. Through-bolts and separators may be used, provided that in beams having a depth of 12 inches or more, no fewer than 2 bolts shall be used at each separator location. When concentrated loads are carried from one beam to the other, or distributed between the beams, diaphragms having sufficient stiffness to distribute the load shall be riveted, bolted or welded between the beams. Where beams are exposed, they shall be sealed against corrosion of interior surfaces, or spaced sufficiently far apart to permit cleaning and painting.

1.18.2. Compression Members.

1.18.2.1. — All parts of built-up compression members and the transverse spacing of their lines of fasteners shall meet the requirements of Sects. 28–1.8 and 28–1.9.

1.18.2.2. — At the ends of built-up compression members bearing on base plates or milled surfaces, all components in contact with one another shall be connected by rivets or bolts spaced longitudinally not more than 4 diameters apart for a distance equal to 1½ times the maximum width of the member, or by continuous welds having a length not less than the maximum width of the member.

1.18.2.3. — The longitudinal spacing for intermediate rivets, bolts or intermittent welds in built-up members shall be adequate to provide for the transfer of calculated stress. However, where a component of a built-up compression member consists of an outside plate, the maximum spacing shall not exceed the thickness of the thinner outside plate times $4{,}000/\sqrt{F_y}$ when rivets are provided on all gage lines at each section, or when intermittent welds are provided along the edges of the components, but this spacing shall not exceed 12 inches. When rivets or bolts are staggered, the maximum spacing on each gage line shall not exceed the thickness of the thinner outside plate times $6{,}000/\sqrt{F_y}$ nor 18 inches. The maximum longitudinal spacing of rivets, bolts or intermittent welds connecting two rolled shapes in contact with one another shall not exceed 24 inches.

1.18.2.4. — Compression members composed of two or more rolled shapes separated from one another by intermittent fillers shall be connected to one another at these fillers at intervals such that the slenderness ratio l/r of either shape, between the fasteners, does not exceed the governing slenderness ratio of the built-up member. The least radius of gyration r shall be used on computing the slenderness ratio of each component part.

1.18.2.5. — Open sides of compression members built up from plates or shapes shall be provided with lacing having tie plates at each end, and at intermediate points if the lacing is interrupted. Tie plates shall be as near the ends as practicable. In main members carrying calculated stress the end tie plates shall have a length of not less than the distance between the lines of rivets, bolts or welds connecting them to the components of the member. Intermediate tie plates shall have a length not less than one-half of this distance. The thickness of tie plates shall be not less than 1/50 of the distance between the lines of rivets, bolts or welds connecting them to the segments of the members. In riveted and bolted construction the pitch in tie plates shall be not more than 6 diameters and the tie plates shall be connected to each segment by at least three fasteners. In welded construction, the welding on each line connecting a tie plate shall aggregate not less than one-third the length of the plate.

1.18.2.6A. — Lacing, including flat bars, angles, channels or other shapes employed as lacing, shall be so spaced that the ratio l/r of the flange included between their connections shall not exceed the governing ratio for the member as a whole. Lacing shall be proportioned to resist a shearing stress normal to the axis of the member equal to 2 percent of the total compressive stress in the member. The ratio l/r for lacing bars arranged in single systems shall not exceed 140. For double lacing this ratio shall not exceed 200. Double lacing bars shall be joined at their intersections. In determining the required section for lacing bars, Formula (1) or (3) shall be used, Kl being taken as the unsupported length of the lacing bar between rivets or welds connecting it to the components of the built-up member for single lacing and 70 percent of that distance for double lacing. The inclination of lacing bars to the axis of the member shall preferably be not less than 60 degrees for single lacing and 45 degrees for double lacing. When the distance between the lines of rivets or welds in the flanges is more than 15 inches, the lacing shall preferably be double or be made of angles.

1.18.2.7. — The function of tie plates and lacing may be performed by continuous cover plates perforated with a succession of access holes. The width of such plates at access holes, as defined in Sect. 28–1.9.2, is assumed available to resist axial stress, provided that: the width-to-thickness ratio conforms to the limitations of Sect. 28–1.9.2; the ratio of length (in direction of stress) to width of hole shall not exceed 2; the clear distance between holes in the direction of stress shall be not less than the transverse distance between nearest lines of connecting rivets, bolts or welds; and the periphery of the holes at all points shall have a minimum radius of 1½ inches.

1.18.3. Tension Members.

1.18.3.1. — The longitudinal spacing of rivets, bolts and intermittent fillet welds connecting a plate and a rolled shape in a built-up tension member, or two plate components in contact with one another, shall not exceed 24 times the thickness of the thinner plate nor 12 inches. The longitudinal spacing of rivets, bolts and intermittent welds connecting two or more shapes in contact with one another in a tension member shall not exceed 24 inches. Tension members composed of two or more shapes or plates separated from one another by intermittent fillers shall be connected to one another at these fillers at intervals such that the slenderness ratio of either component between the fasteners does not exceed 240.

1.18.3.2. — Either perforated cover plates or tie plates without lacing may be used on the open sides of built-up tension members. Tie plates shall have a length not less than two-thirds the distance between the lines of rivets, bolts or welds connecting them to the components of the member. The thickness of such tie plates shall not be less than 1/50 of the distance between these lines. The longitudinal spacing of rivets, bolts or intermittent welds at tie plates shall not exceed 6 inches. The spacing of tie plates shall be such that the slenderness ratio of any component in the length between tie plates will not exceed 240.

Sect. 28-1.19. Camber.

1.19.1. Trusses and Girders. — Trusses of 80 feet or greater span should generally be cambered for approximately the dead load deflection. Crane girders of 75 feet or greater span should generally be cambered for approximately the dead and half live load deflection.

1.19.2. Camber for Other Trades. — If any special camber requirements are necessary in order to bring a loaded member into proper relation with the work of other trades, as for the attachment of runs of sash, the requirements shall be set forth on the plans and on the detail drawings.

1.19.3. Erection. — Beams and trusses detailed without specified camber shall be fabricated so that after erection any minor camber due to rolling or shop assembly shall be upward. If camber involves the erection of any member under a straining force, this shall be noted on the erection diagram.

Sect. 28-1.20. Expansion. — Adequate provision shall be made for expansion and contraction appropriate to the service conditions of the structure.

Sect. 28-1.21. Column Bases.

1.21.1. Loads. — Proper provision shall be made to transfer the column loads, and moments if any, to the footings and foundations.

1.21.2. Alignment. — Column bases shall be set level and to correct elevation with full bearing on the masonry.

1.21.3. Finishing. — Column bases shall be finished in accordance with the following requirements:

1. Rolled steel bearing plates, 2 inches or less in thickness, may be used without planing, provided a satisfactory contact bearing is obtained; rolled steel bearing plates over 2 inches but not over 4 inches in thickness may be straightened by pressing; or, if presses are not available, by planing for all bearing surfaces (except as noted under Requirement 3 of this Section), to obtain a satisfactory contact bearing; rolled steel bearing plates over 4 inches in thickness shall be planed for all bearing surfaces (except as noted under Requirement 3 of this Section).
2. Column bases other than rolled steel bearing plates shall be planed for all bearing surfaces (except as noted under Requirement 3 of this Section).
3. The bottom surfaces of bearing plates and column bases which are grouted to insure full bearing contact on foundations need not be planed.

Sect. 28–1.22. Anchor Bolts. — Anchor bolts shall be designed to provide resistance to all conditions of tension and shear at the bases of columns, including the net tensile components of any bending moments which may result from fixation or partial fixation of columns.

Sect. 28–1.23. Fabrication.

1.23.1. Straightening Material. — Rolled material, before being laid off or worked, must be straight within the tolerances allowed by ASTM specification A6-62T. If straightening is necessary, it shall be done by methods that will not injure the metal.

1.23.2. Gas Cutting. — Gas cutting shall preferably be done by machine. Gas cut edges which will be subjected to substantial stress or which are to have weld metal deposited on them shall be free from gouges; any gouges that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least ½ inch.

1.23.3. Planing of Edges. — Planing or finishing of sheared or gas cut edges of plates or shapes will not be required unless specifically called for on the drawings or included in a stipulated edge preparation for welding.

1.23.4. Riveted and Bolted Construction — Holes. — Holes for rivets or bolts shall be 1/16 inch larger than the nominal diameter of the rivet or bolt. If the thickness of the material is not greater than the nominal diameter of the rivet or bolt plus ⅛ inch, the holes may be punched. If the thickness of the material is greater than the nominal diameter of the rivet or bolt plus ⅛ inch, the holes shall be either drilled from the solid, or sub-punched and reamed. The die for all sub-punched holes, and the drill for all sub-drilled holes, shall be at least 1/16 inch smaller than the nominal diameter of the rivet or bolt.

1.23.5. Riveted and High Strength Bolted Construction — Assembling. — All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting done during assembling shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection.

Rivets shall be driven by power riveters, of either compression or manually-operated type, employing pneumatic, hydraulic or electric power. After driving they shall be tight and their heads shall be in full contact with the surface.

Rivets shall ordinarily be hot-driven, in which case their finished heads shall be of approximately hemispherical shape and shall be of uniform size throughout the work for the same size rivet, full, neatly finished and concentric with the holes. Hot-driven rivets shall be heated uniformly to a temperature not exceeding 1950°F; they shall not be driven after their temperature has fallen below 1000°F.

Rivets may be driven cold if approved measures are taken to prevent distortion of the riveted material. The requirements for hot-driven rivets shall apply except as modified in the *Tentative Specification for Cold-Driven Rivets* of the Industrial Fasteners Institute.

Surfaces of high strength bolted parts in contact with the bolt head and nut shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the surface of a high strength bolted part has a slope of more than 1:20, a beveled washer shall be used to compensate for the lack of parallelism. High strength bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers, shall be free of scale except tight mill scale. They shall be free of dirt, loose scale, burrs, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer or galvanizing.

All A325 and A354, Grade BC, bolts shall be tightened to a bolt tension not less than the proof load given in the applicable ASTM Specification for the type of bolt used. Tightening shall be done with properly calibrated wrenches or by the turn-of-nut method.

Bolts tightened by means of a calibrated wrench, shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. Hardened washers are not required when bolts are tightened by the turn-of-nut method.

1.23.6. Welded Construction. — Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than $\frac{3}{16}$ inch. If the separation is

$\frac{1}{16}$ inch or greater, the size of the fillet welds shall be increased by the amount of the separation. The separation between faying surfaces of lap joints and butt joints on a backing structure shall not exceed $\frac{1}{16}$ inch. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting.

Abutting parts to be butt welded shall be carefully aligned. Misalignments greater than $\frac{1}{8}$ inch shall be corrected and, in making the correction, the parts shall not be drawn into a sharper slope than 2 degrees ($\frac{7}{16}$ inch in 12 inches).

The work shall be positioned for flat welding whenever practicable.

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

All complete penetration butt welds made by manual welding, except when produced with the aid of backing material or welded in the flat position from both sides in square-edge material not more than $\frac{5}{16}$ inch thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Butt welds made with use of a backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Butt welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates, if used, shall be removed upon completion of the weld and the ends of the weld made smooth and flush with the abutting parts.

No welding shall be done when the ambient temperature is lower than 0°F.

Base metal shall be preheated as required to the temperature called for in Table 28–1.23.6 prior to tack welding or welding. When base metal not otherwise required to be preheated is at a temperature below 32°F, it shall be preheated to at least 70°F prior to tack welding or welding. Preheating shall bring the surface of the base metal within 3 inches of the point of welding to the specified preheat temperature, and this temperature shall be maintained as a minimum interpass temperature while welding is in progress. Minimum preheat and interpass temperatures shall be as specified in Table 28–1.23.6.

Where required, multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling, or flaking of weld and base metal from overpeening.

Table 28–1.23.6

Thickness of Thickest Part at Point of Welding	Minimum Preheat and Interpass Temperatures					
	Other Than Low-Hydrogen Welding Processes[1]			Low-Hydrogen Welding Processes[2]		
	A373 Steel	A7, A36 Steel	A441 Steel	A373 Steel	A7, A36 Steel	A441 Steel[3]
To 1″ incl.	None[4]	None[4]	Welding with this process not recommended	None[4]	None[4]	None[4]
Over 1″ to 2″, incl.	100°F	200°F		None[4]	50°F	100°F
Over 2″	200°F	300°F		100°F	150°F	200°F

[1] Welding with ASTM A233 E60XX or E70XX electrodes other than a low-hydrogen class.
[2] Welding with properly dried ASTM A233 EXX15, 16, 18 or 28 electrodes or submerged arc welding with properly dried flux.
[3] Preheating for weldable A242 steel may need to be either higher or lower than these requirements, depending on composition of steel.
[4] Except when base metal temperature is below 32°F.

The technique of welding employed, the appearance and quality of welds made, and the methods used in correcting defective work shall conform to Section 4 — Workmanship, of the *Standard Code for Welding in Building Construction* of the American Welding Society D1.0-63.

1.23.7. Finishing. — Compression joints depending upon contact bearing shall have the bearing surfaces prepared to a common plane by milling, sawing or other suitable means.

1.23.8. Tolerances.

1.23.8.1. Straightness. — Structural members consisting primarily of a single rolled shape shall, unless otherwise specified, be straight within the appropriate tolerances allowed by ASTM Specification A6-62T or as prescribed in the following paragraph. Built-up structural members fabricated by riveting or welding, unless otherwise specified, shall be straight within the tolerances allowed for wide flange shapes by ASTM Specification A6 or by the requirements of the following paragraph.

Compression members shall not deviate from straightness by more than 1/1000 of the axial length between points which are to be laterally supported.

Completed members shall be free from twists, bends and open joints. Sharp kinks or bends shall be cause for rejection of material.

1.23.8.2. Length. — A variation of 1/32 inch is permissible in the overall length of members with both ends finished for contact bearing as in Sect. 28–1.23.7.

Members without ends finished for contact bearing, which are to be framed to other steel parts of the structure, may have a variation from the detailed length not greater than 1/16 inch for members 30 feet or less in length, and not greater than 1/8 inch for members over 30 feet in length.

Sect. 28–1.24A. Protection and Painting.

1.24.1. General Requirements. — Unless subjected to deteriorating conditions, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted.

Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned in accordance with the following paragraph, by brush, spray, roller coating, flow coating, or dipping, at the election of the fabricator.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing, or by other methods elected by the fabricator, of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by thorough sweeping with a fiber brush.

The shop coat of paint is intended to protect the steel for only a short period of exposure, even if it is a primer for subsequent painting to be performed in the field by others.

1.24.2. Inaccessible Surfaces. — Surfaces inaccessible after assembly shall be treated in accordance with Sect. 28–1.24.1 before assembly.

1.24.3. Contact Surfaces. — Contact surfaces shall be cleaned in accordance with Sect. 28–1.24.1 before assembly but shall not be painted.

1.24.4. Finished Surfaces. — Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

1.24.5. Surfaces Adjacent to Field Welds. — Unless otherwise provided, surfaces within two inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

1.24.6A. — After erection and after touch-up of shop coat, steel, unless specifically exempted in this Section 28–1.24A, shall be given a field coat of approved metal protection of another color.

Primary frame steel built into exterior masonry walls shall have adequate protection against corrosion by encasing in one and one-half inches of Portland cement mortar or by a mastic asphalt or pitch one-eighth inch thick or its approved equivalent.

1.24.7A. Protection of Light Gage Steel Construction. — All individual structural members and assembled panels of light gage cold-formed steel construction, except where fabricated of approved corrosion-resistive steel.

or of steel having a corrosion-resistive metallic or other approved coating, shall be protected against corrosion with an acceptable shop coat of paint, enamel, or other approved protection.

After erection where directly exposed to the weather, except when encased in concrete made of non-corrosive aggregates, or where fabricated of approved corrosion-resistive steel, or of galvanized or otherwise adequately protected steel, individual structural members and assembled panels of light gage cold-formed steel construction shall be given an additional coat of acceptable protection.

Exposed siding or sheathing shall be fabricated of approved corrosion-resistive steel or otherwise protected at the ground level for sufficient height above grade as determined by the depth of average snowfall (40 inches).

Floor or roof construction which extends into an exterior wall shall be adequately waterproofed and protected from the weather to prevent corrosion.

Sect. 28–1.25. Erection.

1.25.1. Bracing. — The frame of steel skeleton buildings shall be carried up true and plumb, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including equipment and the operation of same. Such bracing shall be left in place as long as may be required for safety.

Wherever piles of material, erection equipment or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from such loads.

1.25.2. Adequacy of Temporary Connections. — As erection progresses, the work shall be securely bolted, or welded, to take care of all dead load, wind and erection stresses.

1.25.3. Alignment. — No riveting, permanent bolting or welding shall be done until as much of the structure as will be stiffened thereby has been properly aligned.

1.25.4. Field Welding. — Any shop paint on surfaces adjacent to joints to be field welded shall be wire brushed to reduce the paint film to a minimum.

Sect. 28–1.26A. Inspection.

1.26.1. General. — Material and workmanship at all times shall be subject to the inspection of experienced engineers representing the purchaser.

1.26.2. Cooperation. — All inspection as far as possible shall be made at the place of manufacture, and the contractor or manufacturer shall cooperate with the inspector, permitting access for inspection to all places where work is being done.

1.26.3. Rejections. — Material or workmanship not conforming to the provisions of this Code may be rejected at any time defects are found during the progress of the work.

1.26.4A. Inspection of Welding and High Strength Bolts. — The inspection of welding shall be performed in accordance with the provisions of the *Standard Code for Welding in Building Construction*, American Welding Society D1.0-63.

Inspection of high strength bolts shall be performed by a competent inspector qualified by experience and training and approved by the Building Commissioner and shall comply with the provisions of the 1962 Specifications For Structural Joints Using ASTM A-325 bolts.

1.26.5. Identification of High Strength Steels. — Steel which is used for main components and which is required to have a yield point greater than 36,000 psi shall, at all times in the fabricator's plant, be marked to identify its ASTM specification. Identification of such steel in completed members or assemblies shall be marked by painting the ASTM specification designation on the piece, over any shop coat of paint, prior to shipment from the fabricator's plant.

Sect. 28–1.27A. Open Web Steel Joists.

1.27.1. General. — Open Web Steel joists shall mean any open-webbed beam or truss, twenty-four inches or less in depth, produced directly by rolling, cold-forming or pressing. Joists may be fabricated from rolled, cold-formed or pressed shapes by welding, riveting or expanding.

Steel joists shall not be used in the first floor of a building where there is not a basement or cellar below, unless it has clearance above the ground of at least twenty-four inches, and the space below is ventilated either to a heated basement or to the outside air. Ventilation of such space to a heated basement shall consist of at least two remote openings in the basement wall having a total area of at least two square feet for each twenty-five linear feet of wall. Ventilation of such space to outside air shall consist of one or more openings in each exterior wall thereof, well distributed, except that openings need not be provided in the front wall when the space is ventilated in the rear and both side walls. The aggregate area of openings shall be not less than two square feet for each twenty-five linear feet of wall. Openings in exterior walls shall be protected by non-corrodible wire mesh with openings not greater than one-half inch.

1.27.2. Design. — The provisions of this Part for design and materials shall apply to Open Web Steel Joists. Steel members hot-rolled to shape shall be designed in accordance with the provisions of Sections 28–1.0 through 28–1.27A; steel members cold-formed to shape shall be designed in accordance with the provisions of Section 28–1.28A.

Where Open Web Steel Joists are used for other than simple spans under uniformly distributed loading their stresses shall be investigated and be limited to those allowed by this Part. Adequate top flange and lateral bracing shall be provided to support the joist in proper alignment under such loads.

The clear span of joists shall not exceed 24 times their depth in roof construction and shall not exceed 20 times their depth in floor construction.

The deflection due to design live load shall not exceed 1/360 of the clear span for all floors and roofs where a plaster ceiling is attached or suspended, and 1/240 of the clear span in all other cases.

1.27.3. End Bearing. — The ends of steel joists shall extend a distance of not less than 4 inches over masonry or concrete supports and not less than 2½ inches over steel supports, except where opposite joists butt over a narrow steel support and positive attachment is made by welding or bolting, a shorter end bearing length may be used when the bearing stresses are within the allowable working stresses permitted in this Part.

1.27.4. Anchorage. — Joists resting on masonry or concrete supports shall be bedded in mortar and anchored thereto with an anchor equivalent to a ⅜-inch round steel bar not less than 8 inches long. Every joist in floors and roofs shall be anchored.

In roofs where parapet walls are not present, two ½-inch anchor bolts or other equal means shall be used in lieu of the steel bar. The ends of all steel joists resting on steel supports shall be positively attached thereto by either a minimum of two welds 1 inch long or one bolt ½ inch diameter. If uplift forces are a consideration, the anchorage shall be capable of resisting such uplift forces.

1.27.5. Bridging. — Bridging shall be provided for steel joists to afford lateral support during and after erection and to distribute concentrations of live load among adjacent joists. Bridging shall be of approved rigid type. Attachment shall be by welding or mechanical means and shall be capable of resisting a horizontal force of not less than 500 pounds. The ratio of unbraced length to least radius of gyration (l/r) of the bridging member shall not exceed 300. Bridging shall be provided at intervals of not more than 7 feet for spans up to 21 feet, nor more than 8 feet for spans over 21 feet. The ends of all bridging terminating at walls or beams shall be anchored thereto at both top and bottom chords.

Sect. 28–1.28A. Light Gage Cold-Formed Steel Construction.

1.28.1. Design. — All computations for safe load, stress, and deflection of light gage cold-formed steel structural members shall be in accordance with the provisions specified herein.

Where design criteria or applications are not specifically covered in Sect. 28–1.28, the design shall be in accordance with the 1962 Edition of the Specification for the Design of Light Gage Cold-Formed Steel Structural Members of American Iron and Steel Institute.

Properties of sections shall be based on the full cross-section of the members (or net section where the use of a net section is customary) except where the use of a reduced cross-section, or "effective design width," is required.

1.28.1.1. — Maximum allowable overall flat-width ratios, w/t, disregarding intermediate stiffeners and taking as "t" the actual thickness of the element, shall be as follows:

(a) Stiffened compression element having one longitudinal edge connected to a web or flange element, the other stiffened by:

Simple lip.. 60
Any other kind of stiffener........................ 90

(b) Stiffened compression element with both longitudinal edges connected to a web or flange element (U-type or box-type sections).. 500

(c) Compression element stiffened at only one edge.......... 60

1.28.1.2. — The ratio h/t of the webs of flexural members shall not exceed 150

where

h = clear distance between flanges, inches
t = thickness of web, inches

Where a web consists of two or more sheets, the h/t ratio of the individual sheets shall not exceed..150

1.28.2. Allowable Design Stresses. — The maximum allowable unit stresses to be used in design shall be as follows:

1.28.2.1. — Tension on the net section of tension members, and tension and compression, f_b, on the extreme fibers of flexural members shall not exceed the value specified below, except as otherwise specifically provided in this section.

$$f_b = 0.6F_y$$

1.28.2.2. — Except as permitted by this section, allowable stresses shall be based upon the specified minimum properties of the plain material. Utilization, for design purposes, of any increase in material strength that results from a cold-forming operation is permissible provided the increase in strength obtains for the kind of stress, tension of compression, that is to be imposed on the final product in service; and under the limitations prescribed in this section.

1.28.2.3. — The provisions of Section 28–1.28.2.2 shall apply only to the following, regardless of whether the stress to be imposed on the member in service is tension or compression:

1. Axially loaded members, and flanges of flexural members, whose proportions are such that when treated as compression members the quantity Q, determined in accordance with the provisions of Section 28–1.28–2.10 is unity. This includes tubular members composed of flat elements.

2. Cylindrical tubular members in which the ratio D/t of mean diameter to wall thickness does not exceed $3{,}300{,}000/F_y$.

1.28.2.4. — Application of the provisions of Section 28–1.28.2.2 shall be on the following basis:

1. Application of the provisions of Section 28–1.28.2.2 shall be confined to the following:

- Basic Design Stress
- Compression on Elements stiffened at only one edge, Paragraph (1) only
- Laterally unbraced Single Web Beams
- Axially Loaded Compression Members
- Combined Axial and Bending Stresses
- Wind or Earthquake Stresses
- Cylindrical Tubular Members

Application of all other provisions shall be based upon the properties of the plain material before forming.

2. The effect, on mechanical properties, of any welding that is to be applied to the member shall be determined on the basis of tests of full section specimens containing, within the gage length, such welding as the manufacturer intends to use. Any necessary allowance for such effect shall be made in the structural use of the member.

1.28.2.5. — Compression, f_c, in pounds per square inch, on a flat element stiffened at only one edge parallel to the direction of stress:

1. For w/t not greater than 10:

$$f_c = f_b$$

except when f_b exceeds 30,000 psi the maximum w/t ratio for which f_c may be taken equal to f_b shall not exceed

$$\frac{300{,}000}{f_b}$$

In the case of such higher values of f_b the allowable value of f_c for w/t ratio less than 10 but greater than the ratio established by this section shall be obtained by straightline interpolation is to be made between (1) the value of f_b at w/t as specified in this section and (2) $f_c = 30{,}000$ psi at w/t equal to 10.

2. For w/t greater than 10, but not greater than 25:

$$f_c = (1.667 f_b - 8640) - (1/15)(f_b - 12{,}950)w/t$$

For steels with yield point in excess of 50,000 psi the value of f_b to be used for the determination of f_c when w/t exceeds 10 shall be 30,000 psi.

3. For w/t from 25 to 60:
   For Angle Struts: $f_c = 8{,}090{,}000/(w/t)^2$
   For all Other Sections: $f_c = 20{,}000 - 282(w/t)$

1.28.2.6. — To prevent lateral buckling, the maximum compression stress f'_c, in pounds per square inch, on extreme fibers of compression flanges or laterally unsupported straight I-, Z- or channel-shaped flexural members (not including multiple-web deck, U- and closed box-type members and curved of arch members), shall not exceed the allowable stress as specified in Sections 28–1.28.2 or 28–1.28.2.5 nor the following maximum stresses:

1. For I- or channel-shaped sections:

When l/r_y is greater than $10{,}050/\sqrt{f_b}$ but less than $22{,}400/\sqrt{f_b}$:

$$f'_c = \frac{10}{9} f_b - \frac{f_b{}^2}{907 \times 10^6} \left(\frac{l}{r_y}\right)^2$$

When l/r_y is equal to or greater than $22{,}400/\sqrt{f_b}$:

$$f'_c = 280{,}000{,}000/(l/r_y)^2$$

2. For Z-shaped sections:

When l/r_y is greater than $7{,}100/\sqrt{f_b}$ but less than $15{,}900/\sqrt{f_b}$:

$$f'_c = \frac{10}{9} f_b - \frac{f_b{}^2}{453 \times 10^6} \left(\frac{l}{r_y}\right)^2$$

When l/r_y is equal to or greater than $15{,}900/\sqrt{f_b}$:

$$f'_c = 140{,}000{,}000/(l/r_y)^2$$

where

l = the unbraced length of the member, inches.

r_y = the radius of gyration of the entire section of the member about its gravity axis parallel to the web, inches.

1.28.2.7. — The maximum average shear stress, v, in pounds per square inch, on the gross area of the flat web of a beam shall not exceed:

$$v = \frac{64{,}000{,}000}{(h/t)^2} \quad \text{with a maximum of } \tfrac{2}{3} f_b$$

Where the web consists of two or more sheets, each sheet shall be considered as a separate member carrying its share of the shear.

1.28.2.8. — The compressive stress f_w in pounds per square inch in the flat web of a beam due to bending in its plane, shall not exceed f_b nor shall it exceed:

$$f_w = \frac{520{,}000{,}000}{(h/t)^2}$$

1.28.2.9. — For webs of beams subject to both bending and shear stresses, the member shall be so proportioned that such stresses do not exceed the allowable values specified in Sections 28–1.28.2.7 and 28–1.28.2.8 and that the quantity

$$(f'_b/f_w)^2 + (v'/v)^2 \text{ does not exceed unity}$$

where

$$f_w = \frac{520{,}000{,}000}{(h/t)^2}$$

$$v = \frac{64{,}000{,}000}{(h/t)^2}$$

f'_b = actual compressive stress at junction of flange and web, psi.

v' = actual average shear stress, i.e., shear force per web divided by web area, psi.

1.28.2.10. — The average axial stress, P/A, in compression members shall not exceed the values of F_a, as follows:

l/r less than $\dfrac{24{,}200}{\sqrt{f_y}\sqrt{Q}}$: $F_a = 0.515QF_y - \left(\dfrac{QF_y l/r}{47{,}500}\right)^2$

l/r equal to or greater than $\dfrac{24{,}200}{\sqrt{F_y}\sqrt{Q}}$: $F_a = \dfrac{149{,}000{,}000}{(l/r)^2}$

In the above formulas,

P = total load, lbs.;
A = full, unreduced cross-sectional area of the member, sq. inches;
F_a = maximum allowable average axial stress in compression, psi;
l = unbraced length of member, inches; in frames which depend upon their own bending stiffness for lateral stability, the effective length l in the plane of the frame shall be determined by a rational method and shall not be less than the actual unbraced length.
r = radius of gyration of full, unreduced cross-section, inches;
F_y = yield point of steel, psi;
Q = a factor determined as follows:

1. For members composed entirely of *stiffened* elements, "Q" is the ratio between the effective design area, as determined from the effective design widths of such elements, and the full or gross area of the cross-section. The effective design area used in determining Q is to be based upon the basic design stress f_b as defined in Section 28–1.28.2.1.

2. For members composed entirely of *unstiffened* elements, "Q" is the ratio between the allowable compression stress f_c for the weakest element of the cross-section (the element having the largest flat-width ratio) and the basic design stress f_b; where f_c is as defined in Section 1.28.2.5.

3. For members composed of both stiffened and unstiffened elements the factor "Q" is the product of a stress factor Q_s computed as outlined in paragraph (2) above and an area factor Q_a computed as outlined in paragraph (1) above, except that the stress upon which Q_a is to be based shall be that value of the unit stress f_c which is used in computing Q_s; and the effective area to be used in computing Q_a shall include the full area of all unstiffened elements.

The maximum allowable ratio l/r of unbraced length, l, to radius of gyration, r, of compression members shall not exceed 200, except that during construction only l/r shall not exceed 300.

1.28.2.11. — Members subject to both axial compression and bending stresses shall be proportioned to meet the requirements of Section 28–1.6A with the exception that the value of F_a and F_b shall be determined in accordance with this section, and formula (7b) is to be used as shown here:

$$\frac{f_a}{0.515QF_y} + \frac{f'_b}{F_b}$$

shall not exceed unity (applicable only at braced points).

1.28.2.12. — The ratio, D/t, of mean diameter to wall thickness of a cylindrical tubular member in compression or bending shall not exceed $3{,}300{,}000/F_y$.

For compression members, the allowable unit stress, P/A, under axial load shall be prescribed by Section 28–1.28.2.10 with $Q = 1$.

1.28.3. Connections.

1.28.3.1. — The following requirements govern bolted connections of light gage steel structural members:

1. The clear distance between bolts which are arranged in rows parallel to the direction of force, also the distance from the center of any bolt to that end or other boundary of the connecting member towards which the pressure of the bolt is directed, shall not be less than $1\frac{1}{2}d$ nor less than P/f_bt.

where

d = diameter of bolt, inches
P = force transmitted by bolt, lb.
t = thickness of thinnest connected sheet, inches
f_b = basic design stress, as defined elsewhere, psi.

If the ratio of tensile strength to yield point is less than 1.35, a stress equal to the specified minimum tensile strength of the material divided by 2.2 shall be used instead of f_b in applying the provisions of this section.

2. The tension stress on the net section of a bolted connection shall not exceed f_b nor shall it exceed

$$(0.1 + 3d/s)f_b$$

where

s = spacing of bolts perpendicular to line of stress, inches. In the case of a single bolt, s = width of sheet.

d and f_b are as previously defined.

3. The bearing stress on the area $(d \times t)$ shall not exceed $3.5f_b$.

4. Shear on bolts, under dead and live load, shall not exceed the values given in Section 28–1.5.2A.

1.28.3.2. — For all grades of steel, fusion welds shall be proportioned so that the unit stresses therein do not exceed 13,600 psi in shear on the throat of fillet or plug welds. The allowable unit stress in tension or compression on butt welds shall be the same as prescribed for the base metal being joined, provided the weld penetrates 100 percent of the section. Stresses due to eccentricity of loading, if any, shall be combined with the primary stresses; and the combined unit stresses shall not exceed the values given above.

1.28.3.3. — In sheets joined by spot welding (including projection welding) the allowable shear per spot shall be as follows:

Thickness of Thinnest Outside Sheet, In.	Allowable Shear Strength per Spot, lb.	Thickness of Thinnest Outside Sheet, In.	Allowable Shear Strength per Spot, lb.
.010	50	.080	1075
.020	125	.094	1375
.030	225	.109	1650
.040	350	.125	2000
.050	525	.155	3000
.060	725	.185	4000

1.28.4. Protection. — Refer to Sect. 28–1.24.7A.

Sect. 28–1.29. Concrete-Filled Pipe Columns.

1.29.1.A Material. — Pipe for such columns may have round, square, or rectangular cross sections.

Steel equal in quality to that described in Section 28–1.4 shall be used for pipe. Pipe shall be new and full size, shall be made by the seamless process or fully welded to develop equivalent strength. All pipe shall be mill tested and approved. Round pipe shall be standard weight or heavier. The wall thickness of square and rectangular pipe shall not be less than 3/16 inch.

Filling shall be standard weight, machine-mixed, stone or gravel concrete and shall have a minimum compressive strength of 3,500 pounds per square inch when proportioned and tested by procedures described in Part 26. Concrete while being placed shall be compacted by a mechanical method which will ensure complete filling of the pipe with dense concrete of homogeneous quality.

Bases, caps, web ties, brackets and shear heads shall be of steel meeting the requirements of ASTM Standards A373-58T, A7-61T or A36-62T. Such fixtures and their attachments to the pipe and reinforcement shall be such as to ensure that the allowable stresses, under the maximum conditions of loading, are not exceeded.

Longitudinal steel having a yield point approximating that of the pipe may be used to increase the strength of the columns. Such steel shall be new, straight and continuous for the entire length of the column with ends so detailed as to develop the computed stress. The ends of such steel shall be arranged for even bearing with the pipe and milled after filling if necessary to obtain uniform bearing. The strength of this reinforcement shall be calculated by adding its area to the area of the steel pipe and including it in the calculations.

Material surrounding a filled pipe column for fire protection shall not be considered as either load-bearing or as increasing the stiffness.

1.29.2. Design.

1.29.2.1. — The axial load P_a shall not exceed that obtained from Formulas (1) and (2), Section 28–1.5.1.3A multiplied by the effective transformed area A_{tr} and with P_a substituted for F_a and r_{tr}^2 substituted for r^2. The values of A_{tr} and r_{tr}^2 shall be evaluated by

$$A_{tr} = A_s + \frac{A_c}{2n} \qquad r_{tr}^2 = \frac{I_s + \frac{I_c}{2n}}{A_{tr}}$$

in which

A_s = area of the pipe and reinforcing steel
A_c = area of the concrete filling
I_c = moment of inertia of the concrete filling
I_s = moment of inertia of steel pipe and reinforcing

$$n = \frac{E}{E_c} = \frac{E}{60{,}000\sqrt{f'_c}} = \frac{483}{\sqrt{f'_c}}$$

f'_c = concrete compressive strength, psi

1.29.2.2. — The computed bending moment in columns shall take account of the effect of the axial load on the deflection including the deflection induced by the axial load itself. This moment M_r may be approximated by

$$M_r = \frac{C_m M}{1 - \dfrac{P_c(Kl/r_{tr})^2}{149{,}000{,}000 A_{tr}}} \qquad \text{Formula (27)}$$

in which C_m shall be evaluated in accordance with Section 28–1.6.1A with P_c substituted for f_a and P_a substituted for F_a.

M = bending moment neglecting the effect of the axial load on the deflection
P_c = applied axial load
At braced points M_r may be taken equal to M.

1.29.2.3. — Provided that no part of the concrete filling is stressed in tension, columns subjected to bending as well as axial load shall be so proportioned that

$$\frac{P_c}{P_a} + \frac{f_b}{21{,}000} \leq 1$$

in which f_b is the compressive bending stress based on the moment given by Formula 27 — at the point under consideration. The above expression applies directly to columns flexed about one principal axis and to round columns. In the latter case moments acting about several axes shall be added vectorially and f_b obtained from the resultant moment. For square and rectangular columns the second (bending) term shall be treated as

$$\frac{f_{bx} + f_{by}}{21{,}000}$$

At braced points P_a in the above formula may be computed for $\dfrac{Kl_b}{r_{tr}} = 0$ and $C_m = 1$.

1.29.2.4. — If bending is sufficient to cause net tension at some point in the concrete fill the column shall be so proportioned that

$$\frac{P_c}{P_b} + \frac{M_r - sP_c}{M_o} \leq 1$$

In the above

$$P_b = \frac{1}{\dfrac{1}{P_a} + \dfrac{1}{21{,}000 A_{tr}}}$$

s = kern distance for the uncracked section $= \dfrac{r_{tr}^2}{c}$

c = distance from centroid to extreme fiber

M_o = allowable moment with $P_c = 0$ which can be approximated as $21{,}000S$ in which S is the section modulus of the pipe and reinforcing steel alone

The above expression applies to columns flexed about one principal axis and to round columns. In the latter case moments acting about several axes shall be added vectorially to obtain the resultant moment.

For square or rectangular columns with bending about both principal axes, the section shall be so proportioned that

$$\frac{P_c}{P_{b\min.}} + \frac{M_{rx} - s_x P_c}{M_{ox}} + \frac{M_{ry} - s_y P_c}{M_{oy}} \leq 1$$

where the subscripts x and y indicate that the quantity is computed with respect to the x or y axis independently and $P_{b\min.}$ is the smaller of P_{bx} and P_{by}.

1.29.3. Tests. — Copies of sanction tests of filled pipe columns subjected to axial loads made in accordance with this section shall be filed with the Commissioner for each size of column produced by a manufacturer. These tests shall be made on specimens the length of which approximates 24 times the smallest outside dimension of the pipe. Tests shall be made in an approved laboratory. For acceptance the ratio of the test strength to P_a shall not be less than the factor of safety in Formulas (1) and (2), modified as in sec. 1.29.2.1 above excepting that in computing P_a for sanction tests n rather than $2n$ shall be used.

1.29.4. Identification. — Columns shall be labeled with manufacturer's name and date of manufacture.

Sect. 28–1.30A. Cast-Iron Columns.

1.30.1. — Cast-iron columns shall not be used in the primary structural frames of buildings the height of which exceeds one hundred feet or twice the width at the ground level. Cast iron shall not be used for columns required to have four-hour fire-resistive protection.

1.30.2. — The ends of cast-iron columns shall be machined to a smooth plane surface perpendicular to the axis to provide full bearing for the entire cross section of the column.

1.30.3. — Hollow cast-iron columns, except when open at both ends and without flanges, shall have two three-eighths inch holes drilled in the shell to exhibit the thickness thereof. If the columns are cast on the side, both holes shall be at mid-height at ninety degrees from one another about the axis of the column. Additional holes shall be drilled when required by the Commissioner. If the core of a cast-iron column is found to have shifted more than one-quarter the thickness of the shell, the strength shall be computed assuming the thickness all around to be that of the thinnest part.

1.30.4. — Cast-iron columns shall not be smaller than six inches in outside diameter or side, and the thickness of metal shall not be less than three-fourths inch or less than one-twelfth the outside diameter or widest side.

1.30.5. — Cast-iron columns supporting a floor shall not be longer than seventy times the least radius of gyration or twenty-four times the outside diameter or least side. Cast-iron columns supporting roof loads only shall not be longer than ninety-six times the least radius of gyration or thirty times the outside diameter or least side.

1.30.6. — Cast-iron columns shall not be used where the loading is so eccentric as to cause tension, nor shall they be used in garages or other structures where they may be subject to impact from vehicles.

Sect. 28–2.0. Plastic Design.

Sect. 28–2.1A. Scope. — Subject to the limitations contained herein, simple or continuous beams, one and two-story rigid frames classified as Class A construction in Sect. 28–1.2A and similar portions of structures rigidly constructed so as to be continuous over at least one interior support,* may be proportioned on the basis of plastic design, i.e., of their maximum strength. This strength, as determined by rational analysis, shall not be less than that required to support 1.70 times the given live load and dead load for simple and continuous beams. For continuous frames it shall not be less than 1.85 times the given live load and dead load, nor 1.40 times these loads acting in conjunction with 1.40 times any specified wind or earthquake forces.

Connections joining a portion of a structure designed on the basis of plastic behavior with a portion not so designed need be no more rigid than ordinary seat-and-cap angle or standard web connections.

Where plastic design is used as the basis for proportioning continuous beams and structural frames, the provisions relating to allowable working stress, contained in Sects. 28–1.0 through 28.1.26.5 are waived. Except as modified by these rules, however, all other pertinent provisions of these Sections shall govern.

Crane runways shall not be designed continuous over interior vertical supports on the basis of maximum strength. However, rigid frame bents supporting crane runways may be considered as coming within the scope of the rules.

Sect. 28–2.2A. Structural Steel. — Structural steel shall conform to one of the following specifications.

Steel for Bridges and Buildings, ASTM A7-61T
Structural Steel for Welding, ASTM A373-58T
Structural Steel, ASTM A36-62T

Sect. 28–2.3. Columns. — In the plane of bending of columns which would develop a plastic hinge at ultimate loading, the slenderness ratio l/r shall not

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* As used here, "interior support" may be taken to include a rigid frame knee formed by the junction of a column and a sloping or horizontal beam or girder.

exceed 120, l being taken as the distance center-to-center of adjacent members connecting to the column or the distance from such a member to the base of the column. The slenderness ratio of columns covered by Formula (21) shall not exceed 100. The maximum axial load P at ultimate loading shall not exceed $0.6P_y$, where P_y is the product of yield point stress times column area.

Columns in continuous frames, where sidesway is not prevented (a) by diagonal bracing, (b) by attachment to an adjacent structure having ample lateral stability or (c) by floor slabs or roof decks secured horizontally by walls or bracing systems parallel to the plane of the continuous frames, shall be so proportioned that

$$\frac{2P}{P_y} + \frac{l}{70r} \leq 1.0 \qquad \text{Formula (20)}$$

Except as otherwise provided in this section, M_o/M_p, the ratio of allowable end moment to the full plastic bending strength of columns and other axially loaded members, shall not exceed the value given by the following formulas, where they are applicable:

Case I. — For columns bent in double curvature by moments producing plastic hinges at both ends of the columns

$$M_o = M_p \quad \text{when } P/P_y \leq 0.15$$

$$\frac{M_o}{M_p} \leq 1.18 - 1.18\left(\frac{P}{P_y}\right) \leq 1.0 \quad \text{when } P/P_y > 0.15 \qquad \text{Formula (21)}$$

Case II. — For pin-based columns required to develop a hinge at one end only, and double curvature columns required to develop a hinge at one end when the moment at the other end would be less than the hinge value

$$\frac{M_o}{M_p} \leq B - G\left(\frac{P}{P_y}\right) \leq 1.0 \qquad \text{Formula (22)}$$

the numerical values for B and G, for any given slenderness ratio in the plane of bending l/r, being those listed in Tables 4-33 and 4-36. Where l/r in the plane of bending is less than 60, and P/P_y does not exceed 0.15, the full plastic strength of the member may be used ($M_o = M_p$).

Case III. — For columns bent in single curvature

$$\frac{M_o}{M_p} \leq 1.0 - H\left(\frac{P}{P_y}\right) - J\left(\frac{P}{P_y}\right)^2 \qquad \text{Formula (23)}$$

the numerical values for H and J being those given in Tables 5-33 and 5-36.

In no case shall the ratio of axial load to plastic load exceed that given by the following expression:

$$\frac{P}{P_y} = \frac{8{,}700}{(l/r)^2} \quad \text{when } \frac{l}{r} > 120 \qquad \text{Formula (24)}$$

where l and r are the unbraced length and radius of gyration of the column in the plane normal to that of the continuous frame under consideration.

Sect. 28–2.4. Shear. — Unless reinforced by diagonal stiffeners or a doubler plate, the webs of columns, beams, and girders shall be so proportioned that

$$V_u \leq 0.00055 F_y w d$$

where V_u is the shear, in kips, that would be produced by the required ultimate loading, d is the depth of the member, and w is its web thickness.

(Shear stresses are generally high within the boundaries of the connection of two or more members whose webs lie in a common plane. The foregoing provisions will be satisfied, without reinforcing the web within the connection, when its thickness w, in inches, is greater than $23{,}000 M/A_{bc}F_y$, M being the algebraic sum of clockwise and counter-clockwise moment (in kip-feet) applied on opposite sides of the connection web boundary, and A_{bc} the planar area of the connection web, expressed in square inches, and F_y is given in pounds per square inch. When the thickness of this web is less than that given by the above formula the deficiency may be compensated by a pair of diagonal stiffeners or by a reinforcing plate in contact with the web over the connection area.)

Sect. 28–2.5. Web Crippling. — Web stiffeners are required on a member at a point of load application where a plastic hinge would form.

At points on a member where the concentrated load delivered by the flanges of a member framing into it would produce web crippling opposite the compression flange or high tensile stress in the connection of the tension flange, web stiffeners are required

opposite the compression flange when $w < \dfrac{A_f}{t_b + 5k}$

opposite the tension flange when $t_f < 0.4\sqrt{A_f}$

where

w = thickness of web to be stiffened
k = distance from outer face of flange to web toe of fillet of member to be stiffened
t_f = thickness of flange of member to be stiffened
t_b = thickness of flange delivering concentrated load
A_f = area of flange delivering concentrated load

The area of such stiffeners, A_{st}, shall be such that

$$A_{st} \geq A_f - w(t_b + 5k)$$

Their ends shall be fully welded to the inside face of the flange opposite the concentrated tensile load. They may be fitted against the inside face of the flange opposite the concentrated compression load. When the concentrated load delivered by a beam occurs on one side only, the web stiffener need not exceed one-half the depth of the member, but the welding connecting it to the web shall be sufficient to develop $F_y A_{st}$.

Sect. 28–2.6. Minimum Thickness (Width-Thickness Ratios). — Projecting elements that would be subjected to compression involving plastic

hinge rotation under ultimate loading, shall have width-thickness ratios no greater than the following:

Flanges of rolled shapes and flange plates of similar built-up shapes: 8½, except that for rolled shapes an upward variation of 3 percent may be tolerated. The thickness of sloping flanges may be taken as their average thickness. Stiffeners and that portion of flange plates in box sections and cover plates included between the free edge and the first longitudinal row of fasteners or connecting welds: 8½.

The width-thickness ratio of flange plates in box sections and flange cover plates included between longitudinal lines of connecting rivets, high strength bolts or welds, shall not exceed 32.

The depth-thickness ratio of beam and girder webs subjected to plastic bending without axial loading shall not exceed 70 and, when subjected to combined axial force and plastic bending moment at ultimate loading, the value given by the formula

$$\frac{d}{w} \leq 70 - 100\frac{P}{P_y} \qquad \text{Formula (25)}$$

with a minimum value of 43.

Sect. 28–2.7. Connections. — All connections, the rigidity of which is essential to the continuity assumed as the basis of the design analysis, shall be capable of resisting the moments, shears and axial loads to which they would be subjected by the ultimate loading.

Corner connections (haunches), tapered or curved for architectural reasons, shall be so proportioned that the full plastic bending strength of the section adjacent to the connection can be developed, if required.

Stiffeners shall be used, as required, to preserve the flange continuity of interrupted members at their junction with other members in a continuous frame. Such stiffeners shall be placed in pairs on opposite sides of the web of the member which extends continuously through the joint.

Rivets, welds and A307 bolts shall be proportioned to resist the forces produced at ultimate load using unit stresses equal to 1.67 times those given in Sects. 28–1.16A and 28–1.17.

In general, groove welds are preferable to fillet welds, but their use is not mandatory when the strength of the latter at 1.67 times the stress given in Sect. 28–1.17 is sufficient to resist the ultimate load imposed upon a joint.

High strength bolts may be proportioned, on the basis of their minimum guaranteed proof load, to resist the tension produced by the ultimate loading. When used to transmit shear produced by the ultimate loading, one bolt may be substituted for a rivet of the same nominal diameter. High strength bolts may be used in joints having painted contact surfaces when these joints are of such size that the slip required to produce bearing would not interfere with the formation, at ultimate loading, of the plastic hinges assumed in the design.

Sect. 28–2.8A. Lateral Bracing. — Members designed on the basis of ultimate load shall be adequately braced to resist lateral and torsional displace-

ments at the plastic hinge locations associated with the failure mechanism. The laterally unsupported distance, l_{cr}, from such braced hinge locations to similarly braced adjacent points on the member or frame shall not exceed

$$l_{cr} = \left(60 - 40\frac{M}{M_p}\right) r_y \qquad \text{Formula (26)}$$

except that it need not be less than $35r_y$

where

r_y = the radius of gyration of the member about its weak axis
M = the lesser of the moments at the ends of the unbraced segment and

M/M_p, the end moment ratio, is positive when the segment is bent in single curvature and negative when bent in double curvature.

Any greater laterally unbraced length for these segments must be justified by an analysis based upon the predictable amount of restraint present at the ends of the segment in the plane of the computed bending moments.

The foregoing provisions need not apply in the region of the last hinge to form in the failure mechanism assumed as the basis for proportioning a given member, nor in members oriented with their weak axis normal to the plane of bending. However, in the region of the last hinge to form, and in regions not adjacent to a plastic hinge, the maximum distance between points of lateral support shall be such as to satisfy the requirements of Formulas (4), (5A), (5B) and (6) in Sections 28–1.0 through 28–1.26.5 of this Code. For this case the value of f_a and f_b shall be computed from the moment and axial force at ultimate loading, divided by the applicable load factor.

Members built into a masonry wall and having their web perpendicular to this wall can be assumed to be laterally supported with respect to their weak axis of bending.

Sect. 28–2.9. **Fabrication.** — The provisions of Sects. 1.7.5 through 1.26.5 with respect to workmanship shall govern the fabrication of structures, or portions of structures, designed on the basis of maximum strength, subject to the following limitations:

The use of sheared edges shall be avoided in locations subject to plastic hinge rotation at ultimate loading. If used, they shall be finished smooth by grinding, chipping or planing.

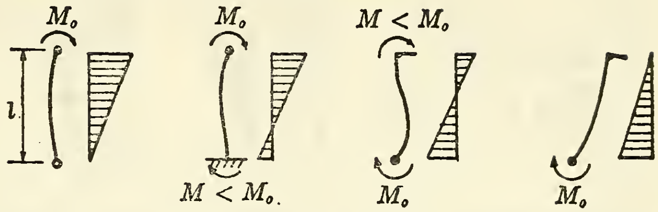
In locations subject to plastic hinge rotation at ultimate loading, holes for rivets or bolts in the tension area shall be subpunched and reamed or drilled full size.

TABLE 28-4-33

FOR 33 KSI SPECIFIED YIELD POINT STEEL

Formula (22)

$$\frac{M_o}{M_p} = B - G\left(\frac{P}{P_y}\right)$$



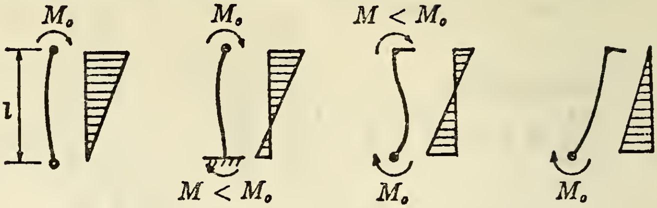
l/r	B	G	l/r	B	G	l/r	B	G
16	1.140	1.172	51	1.164	1.271	86	1.201	1.616
17	1.140	1.174	52	1.165	1.276	87	1.202	1.633
18	1.141	1.177	53	1.165	1.281	88	1.204	1.651
19	1.141	1.179	54	1.166	1.286	89	1.205	1.669
20	1.142	1.182	55	1.167	1.292	90	1.206	1.688
21	1.142	1.184	56	1.168	1.297	91	1.207	1.707
22	1.143	1.187	57	1.169	1.303	92	1.209	1.726
23	1.143	1.189	58	1.170	1.310	93	1.210	1.746
24	1.144	1.191	59	1.171	1.316	94	1.211	1.767
25	1.145	1.194	60	1.172	1.323	95	1.213	1.788
26	1.145	1.196	61	1.173	1.330	96	1.214	1.810
27	1.146	1.198	62	1.174	1.337	97	1.215	1.832
28	1.146	1.200	63	1.175	1.344	98	1.217	1.855
29	1.147	1.203	64	1.176	1.352	99	1.218	1.879
30	1.148	1.205	65	1.177	1.360	100	1.220	1.903
31	1.148	1.207	66	1.178	1.369	101	1.221	1.928
32	1.149	1.209	67	1.179	1.377	102	1.222	1.953
33	1.150	1.212	68	1.180	1.386	103	1.224	1.979
34	1.150	1.215	69	1.181	1.396	104	1.225	2.006
35	1.151	1.217	70	1.182	1.406	105	1.227	2.033
36	1.152	1.220	71	1.183	1.416	106	1.228	2.061
37	1.152	1.222	72	1.184	1.426	107	1.230	2.090
38	1.153	1.225	73	1.186	1.437	108	1.231	2.119
39	1.154	1.228	74	1.187	1.448	109	1.233	2.149
40	1.155	1.231	75	1.188	1.460	110	1.234	2.179
41	1.155	1.234	76	1.189	1.472	111	1.236	2.211
42	1.156	1.237	77	1.190	1.485	112	1.237	2.243
43	1.157	1.240	78	1.191	1.497	113	1.239	2.275
44	1.158	1.243	79	1.192	1.511	114	1.240	2.309
45	1.159	1.247	80	1.194	1.524	115	1.242	2.343
46	1.159	1.251	81	1.195	1.539	116	1.243	2.378
47	1.160	1.254	82	1.196	1.553	117	1.245	2.414
48	1.161	1.258	83	1.197	1.568	118	1.247	2.450
49	1.162	1.263	84	1.198	1.584	119	1.248	2.487
50	1.163	1.267	85	1.200	1.600	120	1.250	2.525

TABLE 28-4-36

FOR 36 KSI SPECIFIED YIELD POINT STEEL

Formula (22)

$$\frac{M_o}{M_p} = B - G\left(\frac{P}{P_y}\right)$$



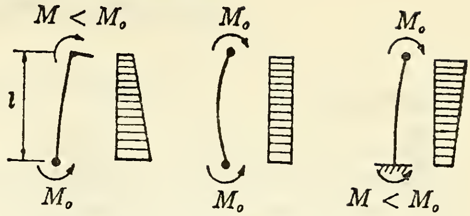
l/r	B	G	l/r	B	G	l/r	B	G
16	1.137	1.173	51	1.163	1.285	86	1.203	1.693
17	1.137	1.176	52	1.164	1.291	87	1.204	1.713
18	1.138	1.179	53	1.165	1.296	88	1.206	1.734
19	1.139	1.182	54	1.166	1.303	89	1.207	1.755
20	1.139	1.184	55	1.166	1.309	90	1.208	1.777
21	1.140	1.187	56	1.167	1.316	91	1.210	1.799
22	1.140	1.189	57	1.168	1.323	92	1.211	1.822
23	1.141	1.192	58	1.170	1.330	93	1.213	1.846
24	1.142	1.194	59	1.171	1.337	94	1.214	1.870
25	1.142	1.196	60	1.172	1.345	95	1.215	1.895
26	1.143	1.199	61	1.173	1.354	96	1.217	1.921
27	1.143	1.201	62	1.174	1.362	97	1.218	1.947
28	1.144	1.204	63	1.175	1.371	98	1.220	1.974
29	1.145	1.206	64	1.176	1.380	99	1.221	2.002
30	1.145	1.209	65	1.177	1.390	100	1.223	2.030
31	1.146	1.211	66	1.178	1.400	101	1.224	2.059
32	1.147	1.214	67	1.179	1.410	102	1.226	2.089
33	1.148	1.216	68	1.180	1.421	103	1.227	2.120
34	1.148	1.219	69	1.181	1.432	104	1.229	2.151
35	1.149	1.222	70	1.183	1.444	105	1.231	2.183
36	1.150	1.225	71	1.184	1.456	106	1.232	2.216
37	1.151	1.228	72	1.185	1.468	107	1.234	2.249
38	1.151	1.231	73	1.186	1.481	108	1.235	2.283
39	1.152	1.234	74	1.187	1.494	109	1.237	2.318
40	1.153	1.237	75	1.189	1.508	110	1.239	2.354
41	1.154	1.241	76	1.190	1.522	111	1.240	2.391
42	1.155	1.244	77	1.191	1.537	112	1.242	2.429
43	1.155	1.248	78	1.192	1.552	113	1.244	2.467
44	1.156	1.252	79	1.194	1.568	114	1.245	2.506
45	1.157	1.256	80	1.195	1.584	115	1.247	2.546
46	1.158	1.260	81	1.196	1.601	116	1.249	2.587
47	1.159	1.265	82	1.197	1.618	117	1.250	2.628
48	1.160	1.270	83	1.199	1.636	118	1.252	2.671
49	1.161	1.275	84	1.200	1.654	119	1.254	2.714
50	1.162	1.280	85	1.201	1.673	120	1.256	2.759

TABLE 28-5-33

FOR 33 KSI SPECIFIED YIELD POINT STEEL

Formula (23)

$$\frac{M_o}{M_p} = 1.0 - H\left(\frac{P}{P_y}\right) - J\left(\frac{P}{P_y}\right)^2$$



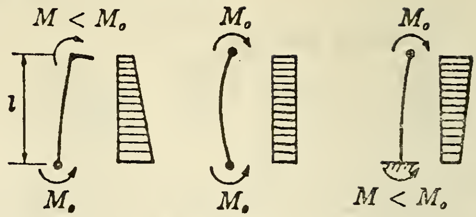
l/r	H	J	l/r	H	J	l/r	H	J
1	.434	.753	41	1.015	.149	81	1.824	− .738
2	.449	.736	42	1.032	.133	82	1.850	− .769
3	.463	.720	43	1.048	.116	83	1.877	− .801
4	.478	.703	44	1.064	.0998	84	1.903	− .833
5	.492	.687	45	1.081	.0832	85	1.930	− .866
6	.506	.671	46	1.097	.0663	86	1.958	− .900
7	.520	.655	47	1.114	.0492	87	1.986	− .934
8	.534	.640	48	1.131	.0318	88	2.014	− .969
9	.548	.624	49	1.148	.0143	89	2.042	−1.004
10	.562	.609	50	1.166	−.0036	90	2.071	−1.041
11	.576	.594	51	1.183	−.0217	91	2.101	−1.077
12	.590	.579	52	1.201	−.0401	92	2.130	−1.115
13	.604	.564	53	1.219	−.0588	93	2.161	−1.153
14	.619	.549	54	1.237	−.0777	94	2.191	−1.192
15	.633	.534	55	1.256	−.0970	95	2.222	−1.231
16	.647	.519	56	1.274	−.117	96	2.254	−1.272
17	.661	.504	57	1.293	−.137	97	2.286	−1.313
18	.675	.490	58	1.312	−.157	98	2.318	−1.354
19	.689	.475	59	1.332	−.177	99	2.350	−1.397
20	.703	.461	60	1.351	−.198	100	2.384	−1.440
21	.717	.447	61	1.371	−.220	101	2.417	−1.484
22	.731	.432	62	1.391	−.241	102	2.451	−1.529
23	.746	.418	63	1.411	−.263	103	2.486	−1.575
24	.760	.403	64	1.432	−.286	104	2.521	−1.621
25	.774	.389	65	1.452	−.309	105	2.556	−1.668
26	.789	.374	66	1.473	−.332	106	2.592	−1.716
27	.803	.360	67	1.495	−.356	107	2.628	−1.765
28	.818	.345	68	1.516	−.380	108	2.665	−1.814
29	.832	.331	69	1.538	−.404	109	2.703	−1.865
30	.847	.316	70	1.560	−.429	110	2.741	−1.916
31	.862	.301	71	1.583	−.455	111	2.779	−1.968
32	.877	.287	72	1.605	−.481	112	2.818	−2.021
33	.892	.272	73	1.628	−.507	113	2.857	−2.057
34	.907	.257	74	1.652	−.534	114	2.897	−2.123
35	.922	.242	75	1.675	−.562	115	2.937	−2.185
36	.937	.227	76	1.699	−.590	116	2.978	−2.242
37	.953	.211	77	1.724	−.618	117	3.020	−2.300
38	.968	.196	78	1.748	−.647	118	3.062	−2.358
39	.984	.180	79	1.773	−.677	119	3.104	−2.417
40	1.000	.165	80	1.799	−.707	120	3.147	−2.478

TABLE 28-5-36

FOR 36 KSI SPECIFIED YIELD POINT STEEL

Formula (23)

$$\frac{M_o}{M_p} = 1.0 - H\left(\frac{P}{P_y}\right) - J\left(\frac{P}{P_y}\right)^2$$



l/r	H	J	l/r	H	J	l/r	H	J
1	.435	.753	41	1.036	.137	81	1.904	− .817
2	.450	.736	42	1.053	.121	82	1.932	− .851
3	.464	.719	43	1.070	.104	83	1.961	− .886
4	.479	.702	44	1.087	.0867	84	1.990	− .922
5	.494	.686	45	1.105	.0692	85	2.020	− .958
6	.508	.670	46	1.122	.0516	86	2.050	− .996
7	.523	.654	47	1.140	.0336	87	2.080	−1.034
8	.537	.638	48	1.158	.0154	88	2.111	−1.072
9	.552	.622	49	1.176	−.0031	89	2.142	−1.112
10	.566	.607	50	1.195	−.0219	90	2.174	−1.152
11	.581	.591	51	1.213	−.0411	91	2.206	−1.193
12	.595	.576	52	1.232	−.0605	92	2.239	−1.234
13	.610	.561	53	1.251	−.0803	93	2.272	−1.277
14	.624	.546	54	1.271	−.100	94	2.306	−1.320
15	.639	.531	55	1.290	−.121	95	2.340	−1.364
16	.653	.516	56	1.310	−.142	96	2.375	−1.409
17	.668	.501	57	1.330	−.163	97	2.410	−1.455
18	.682	.486	58	1.351	−.185	98	2.445	−1.501
19	.697	.472	59	1.371	−.207	99	2.482	−1.549
20	.711	.457	60	1.392	−.229	100	2.518	−1.597
21	.726	.442	61	1.413	−.252	101	2.555	−1.646
22	.741	.428	62	1.435	−.275	102	2.593	−1.696
23	.755	.413	63	1.456	−.299	103	2.631	−1.747
24	.770	.398	64	1.478	−.323	104	2.670	−1.799
25	.785	.384	65	1.501	−.348	105	2.709	−1.852
26	.800	.369	66	1.523	−.373	106	2.749	−1.906
27	.815	.354	67	1.546	−.399	107	2.789	−1.960
28	.830	.340	68	1.570	−.425	108	2.830	−2.016
29	.845	.325	69	1.593	−.452	109	2.871	−2.073
30	.860	.310	70	1.617	−.479	110	2.914	−2.130
31	.876	.295	71	1.641	−.507	111	2.956	−2.189
32	.891	.280	72	1.666	−.535	112	2.999	−2.248
33	.907	.265	73	1.691	−.564	113	3.043	−2.309
34	.922	.249	74	1.716	−.593	114	3.087	−2.371
35	.938	.234	75	1.742	−.623	115	3.132	−2.433
36	.954	.218	76	1.768	−.654	116	3.178	−2.497
37	.970	.202	77	1.794	−.685	117	3.224	−2.562
38	.987	.186	78	1.821	−.717	118	3.271	−2.627
39	1.003	.170	79	1.848	−.750	119	3.318	−2.694
40	1.020	.154	80	1.876	−.783	120	3.366	−2.762

PART 29

EXCAVATIONS AND FOUNDATIONS

ACKNOWLEDGEMENTS

The revision of Part 29 of the Building Code, as amended by Ordinance and published herein, was accomplished by the Technical Committee whose members are listed below. Months and years were spent in accumulating and compiling the data in this part of the code. Many technical societies and professional organizations, representative of the building industry of Boston, assisted in this work by valuable criticism and suggestion. The work was finally reviewed and recommended for approval by an Advisory Committee appointed by Mayor John F. Collins.

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PART 29

EXCAVATIONS AND FOUNDATIONS

Ordinances of 1962, Chapter 10

Chapter 479 of the Acts of 1938 was amended, by striking out Part 29 as amended by chapter 8 of the Ordinances of 1943, and chapter 2 of the Ordinances of 1955, and inserting in place thereof a new Part 29.

Passed by the City Council, October 1, 1962.

Approved by the Mayor, October 3, 1962.

February 25, 1963

PART 29.

EXCAVATIONS AND FOUNDATIONS.

Section 2901. Excavations.—(a) Until provision for permanent support has been made, excavations shall be properly guarded and protected by the persons causing them to be made so as to prevent such excavation from becoming dangerous, in the opinion of the commissioner, to life or limb, or to prevent adjoining soil from moving or caving, or to preserve or protect any wall, building, or structure from injury. Where necessary, excavations shall be sheet-piled, braced, or shored, and permanent excavations shall be protected by retaining walls or other permanent structures to prevent movement or caving of the adjoining soil.

(b) Structures near an excavation and owned by another than the person causing the excavation to be made shall be supported as follows:

(1) Where an excavation is carried below the curb grade, at the common property line, or below the surface of the ground where there is no such curb grade, the person causing such excavation to be made shall, at all times, if accorded the necessary license to enter upon the adjoining land, and not otherwise, at his own expense, preserve and protect from injury any wall, building, or structure, the safety of which may be affected by said excavation, and shall support it by proper foundations. If the necessary license is not accorded to the person making such excavation, then it shall be the duty of the owner refusing to grant such license to make such wall, building, or structure safe and to support it by proper foundations; and, when necessary for that purpose, such owner shall be permitted to enter upon the premises where such excavation is being made.

(2) Where a party wall is intended to be used by the person causing the excavation to be made, he shall, at his own expense, preserve such party wall from injury and shall support it so that the said party wall shall be safe for the purposes intended.

(c) If the person whose duty it shall be under the provisions of this section to guard and protect an excavation, or to prevent adjoining soil from moving or caving, or to preserve or protect any wall, building, or structure from injury, shall neglect or fail so to do, the commissioner may enter upon the premises, and make safe such excavation, wall, building, or other structure as provided in section 116 of Part 1.

Sect. 2902. General Requirements for Foundations.—(a) The foundations of every permanent structure shall be supported by satisfactory bearing material which shall mean:

(1) Natural deposits of rock, gravel, sand, rock flour (inorganic silt), inorganic clay, or any combination of these materials;

(2) Compacted fills which satisfy the provisions of Section 2904 (a) (4);

(3) Natural deposits or artificial fills which can be changed into satisfactory bearing materials by preconsolidation with a temporary surcharge in accordance with the provisions of Section 2904 (a) (5).

(b) Where footings are supported at different levels, or at different levels from footings of adjacent structures, foundation plans shall include vertical sections showing to true scale all such variations in grade. The effect of such differences in footing levels on the bearing materials shall be considered in the design.

(c) Foundations shall be constructed so that freezing temperatures will not penetrate into underlying soils that contain more than five per cent (by weight), passing a No. 200 mesh sieve. The foundations and grade beams of permanent structures, except when founded on sound rock, and except as otherwise provided in Section 2902 (d), shall be carried down at least four feet below an adjoining surface exposed to natural freezing. No foundation shall be placed on frozen soil. Foundations shall not be placed in freezing weather unless adequately protected.

(d) Foundations of detached garages or similar accessory structures not exceeding eight hundred square feet in area and not over one story high, and grade beams of all structures, need not be carried more than one foot below an adjoining surface exposed to natural freezing if the underlying soil to a depth of at least four feet beneath the surface, and extending at least four feet outside the building, is sand, gravel, cinders, or other granular materials containing not more than five per cent (by weight) passing a No. 200 mesh sieve.

(e) Foundations subject to hydrostatic uplift shall have adequate provisions to prevent heaving.

(f) Basements and cellars shall be waterproofed up to the maximum probable ground-water level. Under boilers, furnaces, and other heat-producing apparatus, suitable insulation shall be installed to protect the waterproofing against damage from heat as specified in Part 21. Foundations under heat-producing units shall be so insulated as to prevent evaporation of moisture from any underlying soil that is subject to shrinkage, and to protect the heads of wood piles against damage from heat.

Sect. 2903. Soil Information.—(a) Before issuing a permit for the erection of a permanent structure, or for the alteration of a permanent structure that may affect its foundation, the commissioner shall be furnished with adequate soil data by the applicant. Where borings or tests are required, they shall be made at a sufficient number of locations and to such depths, and they shall be supplemented by such field or laboratory tests and engineering analysis, as are necessary in the opinion of the commissioner. When it is proposed to support the structure directly on bedrock, the commissioner may require drill holes or core borings to be made into the rock to a sufficient depth to prove that bedrock has been reached.

(b) Duplicate copies of the results obtained from all completed and uncompleted borings, plotted to true relative elevation and to scale, and of all test results or other pertinent soil data shall be filed with the commissioner.

Sect. 2904. Classification of Bearing Materials and Allowable Bearing Values.—(a) The terms used in this section shall be interpreted in accordance with generally accepted engineering nomenclature. In addition, the following more specific definitions are used for bearing materials in the Greater Boston area:

(1) Rocks

Shale—A soft, fine-grained sedimentary rock.

Slate—A hard, fine-grained metamorphic rock of sedimentary origin.

Roxbury Puddingstone—A hard, well-cemented conglomerate.

(2) Granular Materials

Gravel—A mixture of mineral grains at least seventy per cent (by weight) of which is retained on a No. 4 mesh sieve and possessing no dry strength.

Sand—A mixture of mineral grains at least seventy per cent (by weight) of which passes a No. 4 mesh sieve and which contains not more than fifteen per cent (by weight) passing a No. 200 mesh sieve.

Coarse Sand—A sand at least fifty per cent (by weight) of which is retained on a No. 20 mesh sieve.

Medium Sand—A sand at least fifty per cent (by weight) of which passes a No. 20 mesh sieve and at least fifty per cent (by weight) is retained on a No. 60 mesh sieve.

Fine Sand—A sand at least fifty per cent (by weight) of which passes a No. 60 mesh sieve.

Well-graded Sand and Gravel—A mixture of mineral grains which contains between twenty-five per cent and seventy per cent (by weight) passing a No. 4 mesh sieve, between ten and forty per cent (by weight) passing a No. 20 mesh sieve, and containing not more than eight per cent (by weight) passing a No. 200 mesh sieve.

(3) Cohesive Materials

Hardpan—A glacial till that generally lies directly over bedrock and consists of a highly compacted, heterogeneous mixture ranging from very fine material to coarse gravel and boulders. It can be identified from geological evidence and from the very high penetration resistance encountered in earth boring and sampling operations.

Clay—A fine-grained, inorganic soil possessing sufficient dry strength to form hard lumps which cannot readily be pulverized by the fingers.

Hard Clay—An inorganic clay requiring picking for removal, a fresh sample of which cannot be molded by pressure of the fingers.

Medium Clay—An inorganic clay which can be removed by spading, a fresh sample of which can be molded by a substantial pressure of the fingers.

Soft Clay—An inorganic clay, a fresh sample of which can be molded with slight pressure of the fingers.

Rock Flour and Inorganic Silt—A fine-grained, inorganic soil consisting chiefly of grains which will pass a No. 200 mesh sieve, and possessing sufficient dry strength to form lumps which can easily be pulverized with the fingers.

(Note: Dry strength is determined by drying a wet pat of soil and breaking it with the fingers.)

(4) Compacted Granular Fill.

(a) A fill consisting of gravel, sand-gravel mixtures, coarse or medium sand, crushed stone, or slag, containing not more than five per cent (by weight) passing a No. 200 mesh sieve, shall be considered satisfactory bearing material when compacted by one of the following methods:

I. In six-inch layers, each layer with at least four coverages with the treads of a crawler-type tractor with a total weight, including equipment, of not less than fifteen tons and operated at its top speed;

II. In twelve-inch layers, with at least three coverages with the wheels of a rubber-tired roller having four wheels abreast and weighted to a total load of not less than thirty-five tons;

III. Other types of materials and other compaction equipment, such as vibrators, may be approved by the Commissioner on the basis of sufficient evidence that they will achieve compacted fills having satisfactory properties.

(b) Application of water is permitted, and for some sands may be required in order to achieve satisfactory traffic-ability and compaction.

(c) The commissioner will require a competent inspector, qualified by experience and training and satisfactory to him, to be on the project at all times while fill is being placed and compacted. The inspector shall make an accurate record of the type of material used, including grain-size curves, thickness of lifts, type of compaction equipment and number of coverages, the use of water and other pertinent data. Whenever the commissioner or the inspector questions the suitability of a material, or the degree of compaction achieved, bearing tests shall be performed on the compacted material in accordance with the requirements of Section 2915. A copy of all these records and test data shall be filed with the commissioner.

(5) Preloaded Highly Compressible Materials.

The Commissioner may allow the use of certain otherwise unsatisfactory natural soils and uncompacted fills for the support of one story structures,

after these materials have been preloaded to not less than one hundred and fifty per cent of the stresses which will be induced by the structure.

The commissioner may require the loading and unloading of a sufficiently large area, conducted under the direction of a competent engineer, approved by the commissioner, who shall submit a report containing a program which will allow sufficient time for adequate consolidation of the material, and an analysis of the preloaded material and of the probable settlements of the structure.

(b) The maximum pressure on soils under foundations shall not exceed the allowable bearing values set forth in the following table, except when determined in accordance with the provisions of Section 2915, and in any case subject to the modifications of subsequent paragraphs of this section.

Class	Material	Allowable Bearing Value in Tons per Square Foot (*)
1	Massive igneous rocks and Roxbury Puddingstone, all in sound condition (sound condition allows minor cracks)	100
2	Slate in sound condition (minor cracks allowed)	50
3	Shale in sound condition (minor cracks allowed)	10
4	Residual deposits of shattered or broken bedrock of any kind except shale	10
5	Hardpan	10
6	Gravel, well-graded sand and gravel	5
7	Coarse sand	3
8	Medium sand	2
9	Fine sand	1 to 2 (‡)
10	Hard clay	5
11	Medium clay	2 (†)
12	Soft clay	1 (†)
13	Rock flour, inorganic silt, shattered shale, or any natural deposit of unusual character not provided for herein	(‡)
14	Compacted granular fill	2 to 5 (‡)
15	Preloaded highly compressible materials	(‡)

* The allowable bearing value given in this section, or when determined in accordance with the provisions of Section 2915, will assure that the soils will be stressed within limits that lie safely below their strength. However, such allowable bearing values for Classes 9 to 12, inclusive, do not assure that the settlements will be within the tolerable limits for a given structure.

† Alternatively, the allowable bearing value shall be computed from the unconfined compressive strength of undisturbed samples, and shall be taken as 1.50 times that strength for round and square footings, and 1.25 times that strength for footings with length-width ratios of greater than four; for intermediate ratios interpolation may be used.

‡ Value to be fixed by the commissioner in accordance with Sections 2915 and 2903.

(c) The tabulated bearing values for rocks of Classes 1 to 3, inclusive, shall apply where the loaded area is on the surface of sound rock. Where the loaded area is below such surface these values may be increased ten per cent for each foot of additional depth, but shall not exceed three times the tabulated values.

(d) The allowable bearing values of materials of Classes 4 to 9, inclusive, may exceed the tabulated values by five per cent for each foot of depth of the

loaded area below the minimum required in Section 2906 (c), but shall not exceed twice the tabulated values. For areas of foundations smaller than three feet in least lateral dimension, the allowable design bearing values shall be one third of the allowable bearing values multiplied by the least lateral dimension in feet.

(e) The tabulated bearing values for Classes 10 to 12, inclusive, shall apply only to pressures directly under individual footings, walls, and piers; and in case structures are founded on or are underlain by deposits of these classes, the total load over the area of any one bay or other major portion of the structure, minus the weight of all materials removed, divided by the area, shall not exceed one half the tabulated bearing values. Whenever there is any doubt about the settlements of a proposed structure or the effect on neighboring structures, the commissioner shall require that the magnitude and distribution of the probable settlements be investigated as specified in Section 2916.

(f) The computed vertical pressure at any level beneath a foundation shall not exceed the allowable bearing values for the material at that level. Computation of the vertical pressure in the bearing materials at any depth below a foundation shall be made on the assumption that the load is spread uniformly at an angle of sixty degrees with the horizontal; but the area considered as supporting the load shall not extend beyond the intersection of sixty degree planes of adjacent foundations.

Sect. 2905. Foundation Loads.—(a) The loads to be used in computing the pressure upon bearing materials directly underlying foundations shall be the live and dead loads of the structure, as specified in Part 23, including the weight of the foundations and of any immediately overlying material, but deducting from the resulting pressure per square foot the total weight of a one-square-foot column of soil, including the water in its voids, which extends from the lowest immediately adjacent surface of the soil to the bottom of the footing, pier or mat. Foundations shall be constructed so as to resist the maximum probable hydrostatic pressures.

(b) Eccentricity of loading in foundations shall be fully investigated and the maximum pressure on the basis of straight-line distribution shall not exceed the allowable bearing values.

(c) Where the pressure on the bearing material due to wind is less than one third of that due to dead and live loads, it may be neglected in the foundation design. Where this ratio exceeds one third, foundations shall be so proportioned that the pressure due to combined dead, live, and wind loads shall not exceed the allowable bearing values by more than one third.

(d) One-story structures without masonry walls and not exceeding eight hundred square feet in area may be founded on a layer of satisfactory bearing material not less than three feet thick, which is underlain by highly compressible material, provided that the stresses induced in the unsatisfactory material by the live and dead loads of the structure and the weight of any new fill, within or adjacent to the building area, will not exceed two hundred and fifty pounds per square foot.

(e) The pressures against foundation walls and other types of retaining walls shall be fully investigated. Particular attention shall be paid to restraints which may cause substantially larger earth pressures than the active earth pressure, and to the type of backfill and drainage. In addition to earth pressure, such walls shall be designed and constructed to resist hydrostatic pressures corresponding to the maximum probable ground water level.

Sect. 2906. Foundation Design.—(a) Foundations shall be designed to distribute to the supporting materials all vertical, horizontal and inclined loads, as specified in Section 2905, without exceeding the allowable stresses specified elsewhere in this Code for the materials of which the foundations are to be constructed.

(b) Plain concrete in foundations shall have a minimum compressive strength at twenty-eight days of two thousand pounds per square inch. Reinforced concrete in foundations shall have a minimum compressive strength of twenty-five hundred pounds per square inch at twenty-eight days.

(c) The bottom surface of any footing resting on material of Classes 4 to 15, inclusive, shall be at least eighteen inches below the lowest ground surface or the surface of a floor slab bearing directly on the soil immediately adjacent to the footing.

(d) Whenever, in an excavation, soil and ground water conditions are such that an inward or upward seepage is produced in the bearing material, special excavating methods and control of ground water shall be employed to prevent disturbance of the bearing material in the excavation or under existing structures. If there is evidence of disturbance of the bearing material, the extent of the disturbance shall be evaluated and appropriate remedial measures taken, satisfactory to the commissioner.

Sect. 2907. Footings and Foundation Piers.—(a) The footings of foundation walls or piers shall be of plain or reinforced concrete or other satisfactory masonry, or steel grillages. Structural steel grillage foundations shall have at least six inches of concrete cover below the bottom of the steel and shall have at least four inches of concrete cover above the steel and between the sides of the steel and the adjacent soil. Footings of wood may be used under temporary structures.

(b) A foundation pier is here defined as a structural member which extends to a satisfactory bearing material, and which may be constructed in an excavation that afterwards is backfilled by an approved method, or by filling the excavation with concrete, or which may be built by sinking an open or pneumatic caisson.

(1) The manner of construction shall be by non-displacement methods and shall permit inspection of the bearing material in place.

(2) The bases of foundation piers may be enlarged by spread footings, pedestals or belled bottoms.

(3) Bell-shaped bases shall have a minimum edge thickness of four inches. The bell roof shall slope not less than sixty degrees with the horizontal unless the base is designed in accordance with Part 26.

(4) Foundation piers may be designed as concrete columns with continuous lateral support. The unit compressive stress in the concrete at the least cross section shall not exceed twenty-two and one half per cent of the twenty-eight day strength of the concrete nor nine hundred pounds per square inch.

(5) When the center of cross section of a foundation pier at any level deviates from the resultant of all forces more than one sixtieth of its height, or more than one tenth of its diameter, it shall be reinforced as provided in Part 26. The restraining effect of the surrounding soil may be taken into account.

(6) With approval of the commissioner, concrete may be placed through still water by means of a properly operated tremie or bottom-dump bucket.

(7) The owner shall engage a competent inspector, qualified by experience and training and satisfactory to the commissioner, to be present at all times while foundation piers are being installed, to inspect and approve the bearing soil and the placing of the concrete. The inspector shall make a record of the type of bearing soil upon which the pier rests, of the dimensions of the pier, and of the class of concrete used in its construction. A copy of these records shall be filed in the office of the commissioner.

Sect. 2908. Driven Piles—General Requirements.—(a) Types of pile construction not specifically provided for in this part shall meet such additional requirements as may be prescribed by the commissioner.

(b) A detached column supported by piles shall rest upon not less than three piles, at least one of which is offset; except that for one story buildings a detached column may rest upon two piles when its axis is not more than one and one half inches off the line connecting the centers of the two piles, or upon a single pile when other than wood or wood-composite piles are used, and its axis is not more than one and one half inches off the center of the pile.

(c) A foundation wall, restrained laterally so as to ensure stability both during and after construction, may be supported by a single row of piles.

(d) The method of driving shall be such as not to impair the strength of the pile and shall meet with the approval of the commissioner. Measurements to determine the value of "s" shall not be made immediately after the introduction of fresh cushion block material, or an interruption in the driving operation or when the pile head is shattered, broomed, crumpled, or otherwise damaged.

The cushion block, where used, shall be of hardwood with its grains parallel with the axis of the pile and be enclosed in a tight-fitting steel housing, or an approved equal. Wood chips, pieces of rope, old hose, or automobile tires and similar materials shall not be used as a cushion block.

Shattered, broomed, crumpled, or otherwise damaged pile heads shall be cut back to sound material before continuing the driving.

In case a follower is used, it shall be of steel, seasoned white oak or hickory, equipped on its lower end with a metal socket or hood suitable for encasing the pile head and to protect it from being damaged during driving.

(e) Jetted piles shall be driven to the required resistance after the flow of jet water has stopped, except as provided in Section 2909 (c) (5).

(f) When piles have been damaged in driving, or driven in locations other than those indicated on the plans, or that have capacities less than required by the design, the affected pile groups and pile caps shall be investigated and if necessary, the pile groups or pile caps shall be redesigned or additional piles shall be driven to replace the defective piles.

(g) Concrete for capping piles shall be proportioned for a minimum compressive strength at twenty-eight days of at least twenty-five hundred pounds per square inch. The concrete shall extend not less than twelve inches above the pile heads and shall fill the space between and around the piles for a depth of at least three inches. The minimum horizontal distance from the edge of the pile cap to the nearest pile surface shall be six inches and there shall be at least two inches of concrete between the top of a pile and steel reinforcement.

(h) Where piles are driven through soft soil to hard bearing material providing high point resistance, the grades of all piles or pile casings previously driven or redriven shall be measured to detect uplift; and if uplift of one half inch or more occurs in any pile or pile casing, such pile or pile casing shall be redriven to its original point elevation and thereafter to the required final driving resistance.

(i) The length of a pile below the ground surface shall be considered as a plain column with continuous lateral support. The length above the ground surface shall be designed as an unsupported column in accordance with the applicable provisions of this code.

(j) The owner shall engage a competent inspector, qualified by experience and training and satisfactory to the commissioner, to be present at all times while piles are being driven and to inspect all work in connection with the piles. The inspector shall make an accurate record of the material and the principal dimensions of each pile, of the weight and fall of the ram, the type, size, and make of hammer, the number of blows per minute, the energy per blow, the number of blows per inch for the last six inches of driving, together with the grades at point and cut-off. A copy of these records shall be filed in the office of the commissioner.

Sect. 2909. Allowable Load on Piles.—(a) The supporting capacity of piles shall be obtained from bearing upon or embedment in bearing materials as defined in Section 2904.

(b) The allowable load on a single pile shall be limited by the requirement that such load shall not cause excessive movement of the pile relative to the soil. Satisfactory proof of this load can be obtained from load tests conducted in accordance with Section 2915. In the absence of such proof of the supporting capacity, except for the types of piles covered in Sections 2912 (d) and 2913 (d), the load on a single pile shall not exceed the *higher* of the two values determined in accordance with Sections 2909 (c) and 2909 (d).

(c) (1) The allowable load may be computed by means of the following driving formula:

$$R = \frac{1.7\,E}{s + 0.1\sqrt{\frac{w_p}{w_r}}}$$

where

R — allowable pile load in pounds

E — energy per blow in foot-pounds which for drop hammers is the product of the weight in pounds of the hammer and the height of fall in feet, and which for other types of hammers may be taken as that established by the hammer manufacturer. For batter piles, proper allowance shall be made for the resultant loss of energy.

$\frac{w_p}{w_r}$ = the ratio of the weight w_p of the pile and other driven parts to the weight w_r of the striking part of the hammer, except that this ratio shall not be entered into the formula as less than unity.

s = the average penetration in inches per blow for the final six inches of driving, except that if an abrupt high increase in resistance is encountered, "s" shall be taken as the average penetration per blow for the last five blows. The minimum value of "s" which may be used in the formula is five hundredths of an inch.

(2) The energy E per blow in foot-pounds delivered by the hammer shall be numerically not less than fourteen per cent of R in pounds and $\frac{w_p}{w_r}$ shall not be greater than 3.5.

(3) The value of "s" must be determined with the hammer operating at not less than ninety per cent of the maximum number of blows per minute for which the hammer is designed.

(4) If the driving of the pile has been interrupted for more than one hour, the value of "s" shall not be determined until the pile is driven at least an additional twelve inches, except when it encounters refusal on or in a material of Classes 1 to 5, inclusive.

(5) When the constant tapered portion of a pile, including a timber pile, is driven through a layer of gravel, sand, or hard clay (Classes 6 to 10, inclusive, and Class 14) exceeding five feet in thickness, and through an underlying soft stratum, the bearing capacity shall not be determined in accordance with the driving formula, unless jetting is used during the entire driving of the tapered portion of the pile through the layer of gravel, sand, hard clay, or Class 14 material, or unless a hole is pre-excavated through said layer for each pile.

(d) The allowable load on a pile stopped in *inorganic clay as found in Greater Boston*, may be based on a friction value of five hundred pounds per square foot of embedded pile surface for a design load not to exceed twenty-two tons, or on a friction value determined from pile load tests. The em-

bedded length shall be the length of the pile below the surface of the inorganic clay, or below the surface of immediately overlying satisfactory bearing material. The area of embedded pile surface shall be computed by multiplying the embedded length by the perimeter of the smallest circle or polygon that can be circumscribed around the average section of the embedded length of the pile. The method of determining the allowable load described in this paragraph shall not be used for a pile in which the drive-pipe is withdrawn or for piles which are driven through the clay to or into firmer bearing materials.

(e) In case piles in clusters are driven under the provisions of Section 2909 (d), the allowable load shall be computed for the smaller of the following two areas: (1) the sum of the embedded pile surfaces of individual piles; (2) the area obtained by multiplying the perimeter of the polygon circumscribing the cluster at the surface of the satisfactory bearing material by the average embedded length of pile.

(f) The allowable load on a single pile installed by jacking shall not exceed one half the load applied to the pile at the completion of jacking, provided that the final load is kept constant for a period of four hours and that the settlement during that period does not exceed one twentieth of an inch.

(g) Where weaker materials underlie the bearing material into which the piles are driven, the allowable pile load shall be limited by the provision that the vertical pressures in such underlying materials produced by the loads on all piles in a foundation shall not exceed the allowable bearing values of such materials, as given in Section 2904, or determined in accordance with the provisions of Section 2915. Piles or pile groups shall be assumed to transfer their loads to the underlying materials by spreading the load uniformly at an angle of sixty degrees with the horizontal, starting at a polygon circumscribing the piles at the top of the satisfactory bearing material in which they are embedded; but the area considered as supporting the load shall not extend beyond the intersection of the sixty degree planes of adjacent piles or pile groups.

(h) Where a pile or a group of piles is placed in subsiding fill or soil, the effect of the downward frictional forces shall be given consideration in the design.

(i) The allowable bearing value of a pile shall not be limited to the value obtained by multiplying its point area by the allowable bearing value given in Section 2904.

Sect. 2910. Wood Piles—General Requirements.—(a) Every wood pile shall be in one piece, cut from a sound live tree, and free from defects which may materially impair its strength or durability. It shall be butt-cut above the ground swell, and shall have substantially uniform taper from butt to point. Wood piles shall measure at least six inches in smallest diameter at the point and at least ten inches in smallest diameter at the cut-off, these measurements being taken under the bark. The axis of a wood pile shall not deviate from a straight line more than one inch for each ten feet of length nor more than six inches for the entire length.

(b) The load on a wood pile shall not exceed the allowable load specified in Section 2909 and, for a pile of the minimum dimensions specified in this section, shall not exceed twelve tons for Spruce, Norway Pine, and woods of similar strength which will be referred to as Type A, nor sixteen tons for Oak, Southern Yellow Pine, and woods of similar strength which will be referred to as Type B. These loads may be increased for each full inch by which both the cut-off and point diameters exceed the minima specified, by three tons for woods of Type A, but not to exceed a total load of twenty-four tons, and by four tons for woods of Type B, but not to exceed a total load of thirty tons.

(c) The load on wood piles driven to bearing on materials of Classes 1 to 5, inclusive, shall be not more than sixty per cent of that allowed in Section 2910 (b).

(d) Piles shall be cut to sound wood before capping is placed.

(e) The center-to-center spacing of wood piles shall be not less than two and one half times the cut-off diameter.

(f) To avoid damage to the pile, the size of the hammer shall be such that the driving energy in foot-pounds per blow shall not exceed numerically the point diameter of the pile in inches multiplied by fifteen hundred. The total driving energy in foot-pounds for six inches of penetration shall for all types of hammers be numerically no greater than the point diameter in inches times twenty-two thousand for woods of Type A or times thirty-two thousand for woods of Type B. For the last inch of penetration the energy in foot-pounds shall not exceed numerically the point diameter in inches multiplied by six thousand. In any case driving shall be stopped immediately when abrupt high resistance to penetration is encountered.

(g) The cut-off grade for untreated wood piles shall be below the probable permanent ground-water level, and shall be subject to the commissioner's approval.

(h) The Commissioner may require the owner to install and maintain in good condition at least one ground-water observation well within the building, which shall be accessible to the commissioner.

(i) **Additional Requirements for Treated Piles**

(1) Timber piles pressure treated with creosote or creosote-coal-tar solution, and conforming to the requirements of this section, may be cut off above permanent ground water level when used for the support of buildings not exceeding two stories in height.

(2) Before any treated piles are driven, the commissioner shall be furnished three copies of a certificate of inspection, issued by an approved independent testing laboratory, certifying that the piles were free of decay, were properly peeled and otherwise prepared before treatment; and that the method of treatment, the chemical composition and the amount of retention of the preservative conform to the requirements of this section.

(3) Treated piles shall be of Norway Pine, Southern Yellow Pine, or Douglas Fir and shall be impregnated with preservative in accordance with specifications of the American Wood Preservers' Association, as follows:

C1–61, "Standard for Preservative Treatment by Pressure Processes—All Timber Products" and C3–60, "Standard for the Preservative Treatment of Piles by Pressure Processes."

(4) Piles exposed to sea water shall be Southern Yellow or Norway Pine, and the preservative used shall conform to the requirements for Grade B of P2–58, "Standard for Creosote-Coal-Tar Solutions" of the American Wood Preservers' Association. For piles not exposed to sea water, the preservative used shall conform to P1–54, "Standard for Creosote" of the American Wood Preservers' Association.

(5) The retention of preservative shall be not less than twenty pounds per cubic foot for piles exposed to sea water and not less than twelve pounds per cubic foot for other piles.

(6) After being cut to grade, the top surface of the pile shall be brush treated with not less than three heavy coatings of the treating material applied hot.

Sect. 2911. Precast Concrete Piles.—(a) Precast concrete piles shall be so proportioned, cast, cured, handled, and driven as to resist without significant cracking the stresses induced by handling and driving as well as by loads. The minimum lateral dimension of a precast concrete pile shall be twelve inches except that the lower six feet may taper to eight inches at the point exclusive of the metal point, if used. Each pile shall be cast in one piece. The concrete shall have a minimum compressive strength of four thousand pounds per square inch. No pile shall be handled or driven until it has cured sufficiently to develop the necessary strength as shown by standard test specimens made from the same batches of concrete cured under similar conditions.

(b) Except as otherwise specified herein, piles shall be proportioned so as to satisfy the requirements of Part 26. Additional requirements for steel reinforcement are as follows: For a length equal to at least three times the minimum lateral dimension at both ends of the pile, lateral ties shall be spaced not over three inches center-to-center or an equivalent spiral shall be provided. Steel reinforcement shall be embedded in concrete forming the body of the pile a net distance of at least one and one half inches from any exposed surface and in piles exposed to sea water such coverage shall be at least three inches.

(c) The maximum water-cement ratio and the minimum cement content of the concrete for piles exposed to sea water shall be four and one half gallons per sack and eight sacks per cubic yard, respectively.

(d) The minimum spacing center-to-center of precast concrete piles shall be two and one half times the square root of the cross-sectional area at the butt.

(e) When precast concrete piles are driven to or into bearing materials of Classes 1 to 5, inclusive, or through materials containing boulders, they shall have metal tips of approved design.

(f) The load on a precast concrete pile shall not exceed the allowable load specified in Section 2909, and shall not exceed fifty tons for a pile of one

square foot cross-sectional area. For piles of larger cross-section, this limit of load may be increased in proportion to increase in area, but not to exceed a total load of ninety tons.

Sect. 2912. Cast-in-Place Concrete Piles.—(a) In this section a distinction is made between poured-concrete piles and compacted-concrete piles. A poured-concrete pile is formed by pouring concrete into a driven casing or drive-pipe that is installed in the ground either permanently or temporarily. A compacted-concrete pile is formed by placing concrete having zero slump, in small batches, and compacting each batch.

(b) All cast-in-place concrete piles shall be so made and placed as to ensure the exclusion of all foreign matter and to secure a well formed unit of full cross section. The minimum strength of concrete for cast-in-place piles shall be three thousand pounds per square inch. While placing the concrete, the casing or drive-pipe shall be free of water.

(c) Poured-Concrete Piles

(1) The diameters of metal-cased poured-concrete piles, when measured on the outside of a plain cylinder, or the outside of horizontal, helical or vertical corrugations, shall be not less than eight inches, one foot above the point, nor less than twelve inches at cut-off. The shape of the pile may be cylindrical, or conical, or a combination thereof, or it may be a succession of cylinders of equal length, with the change in diameter of adjoining cylinders not exceeding one inch.

(2) For uncased poured-concrete piles (i.e., when no metal casing is left in the ground) the inside diameter of the drive-pipe shall be not less than fourteen and one half inches.

(3) The load on poured-concrete piles shall not exceed the allowable load specified in Section 2909, nor twenty-two and one half per cent of the twenty-eight day strength of the concrete, but not exceeding nine hundred pounds per square inch, when applied to the cross-sectional areas computed on the following bases:

I. For metal-cased piles driven to and into materials of Classes 1 to 4 inclusive, using the diameter measured one (1) foot above the point, except that when the rock is immediately overlain by a bearing stratum consisting of one or a combination of bearing materials of Classes 5 and 6, using the diameter at the surface of the bearing stratum, and as further specified in Section 2912 (c) (1).

II. For metal-cased piles, driven through compressible materials, including Classes 11, 12, 13, and 15 and into a bearing stratum consisting, of one or a combination of bearing materials of Classes 5 to 10, inclusive, using the diameter at the surface of the bearing stratum and as further specified in Section 2912 (c) (1).

III. For uncased piles driven to or into any bearing material, using the inside diameter of the drive-pipe minus three inches.

IV. In no case shall the maximum load on a poured-concrete pile exceed ninety tons.

(4) Immediately before filling with concrete, the inside of the casing shall be thoroughly cleaned to the bottom and inspected by lowering a light bulb, or by means of a light beam. To be accepted: (a) the diameter shall not vary more than twenty per cent from the original value, (b) the point of the casing shall not deviate more than ten per cent of the length of the pile from the design alignment, and (c) the casing shall not deviate by more than four per cent of the length of the casing from a straight line connecting the midpoints of the ends of the casing. If the bottom of the casing is out of sight, the shape and alignment of the casing shall be surveyed with a suitable instrument. No load shall be allowed on a pile, the casing of which shows signs of buckling.

(5) The spacing of poured-concrete piles shall be such as to ensure the preservation of the full cross-section. The spacing center-to-center shall be not less than two and one half times the outside diameter of the drive-pipe or of the casing at midlength. No casing or drive-pipe shall be filled with concrete until all casings or drive-pipes within a radius of seven feet, or within the heave range, whichever is the greater, have been driven to the required resistance.

(d) Compacted Concrete Piles

The load on compacted concrete piles shall be limited by the provisions of Section 2909 (g), except that the circumscribing polygon shall start at the junction of the shaft and the enlarged base, and the bearing area shall be taken at planes six feet or more below said junction; and the allowable load on a compacted concrete pile shall not exceed one hundred and twenty tons. The installation of such piles shall fulfill the following listed requirements:

(1) The drive-pipe used for installing the pile shall be not less than twenty inches outside diameter.

(2) The enlarged base of the pile shall be formed on or in bearing materials of Classes 1 to 8, inclusive.

(3) The concrete shall have minimum compressive strength at twenty-eight days of four thousand pounds per square inch, shall be of zero slump, and shall be placed in batches not to exceed five cubic feet in volume.

(4) The last batch of concrete shall be driven into the enlarged base with not less than twenty blows, each of not less than one hundred and thirty thousand foot-pounds.

(5) As the drive pipe is being withdrawn, not less than two blows of at least thirty thousand foot-pounds each shall be applied to compact each batch of concrete in an uncased shaft.

(6) An uncased shaft shall not be formed through inorganic clay or inorganic silt unless an excavation at least equal to the inside diameter of the drive-pipe is first augered through such soil, or the individual piles are located more than nine feet apart.

(7) An uncased shaft shall not be formed through peat or other organic soils.

(8) A permanent metal-cased shaft, not less than sixteen inches in diameter, shall be installed through inorganic clay or inorganic silt if requirement (6) is not fulfilled. The permanent metal casing shall be

fastened to the enlarged base in such a manner that the two will not separate. The concrete may be placed in the metal casing in the same manner as for poured-concrete piles. No metal casing shall be filled with concrete until after all piles within a radius of at least nine feet have been driven. The stresses in metal-cased shafts shall not exceed nine hundred pounds per square inch on the concrete and, in addition, eight thousand five hundred pounds per square inch on the steel casing, provided that its wall thickness is at least two-tenths of an inch.

(9) The center-to-center spacing of piles shall be not less than four feet and six inches.

Sect. 2913. Steel and Steel-Concrete Piles.—(a) At locations where steel and steel-concrete piles will be in contact with cinders, slag, organic soils, or other materials that might cause corrosion of steel, one of the following procedures shall be used:

(1) Remove all such objectionable material from within the area of the structure and replace with inorganic soil.

(2) Deduct one-eighth of an inch in thickness from all surfaces in contact with the objectionable material when computing the area of steel for support of load. This reduction shall be applied from pile cut-off grade to a grade fifteen feet below the bottom of the objectionable material.

(3) Effectively protect the steel surface from pile cut-off grade to a grade fifteen feet below the bottom of the objectionable materials; e.g., by means of cathodic protection or by a cover of at least three inches of concrete.

At locations where steel and steel-concrete piles will be in contact with sea water, the steel from a grade ten feet below the ground surface to at least five feet above mean high tide shall be protected by at least three inches of concrete. The maximum water-cement ratio and the minimum cement content of the concrete shall be four and one half gallons per sack, and eight sacks per cubic yard, respectively.

(b) Concrete-Filled Pipe Piles

(1) Piles consisting of steel pipes and concrete-filled after driving, shall have an outside diameter of not less than ten and three quarters inches and a pipe wall thickness of at least two-tenths of an inch. The material of the pipe shall meet the requirements for Grade 2 in Specifications for Welded and Seamless Steel Pipe Piles, (A252–59) of the American Society for Testing Materials. Splices shall be welded to one hundred per cent of the strength of the pipe. Pipes may be driven open-ended or closed-ended, and the provisions of the section apply to both types.

(2) After driving all pipes within a seven foot radius, and immediately before filling with concrete, the inside of the pipe shall be thoroughly cleaned to the bottom and inspected by lowering a light bulb, or by means of a light beam. To be acceptable: (a) the diameter shall not vary more than twenty per cent from the original value, (b) the point of the pile shall not deviate more than ten per cent of the length of the pile from the design alignment and (c) the pile shall not deviate by more than six per cent of the

length of the pile from a straight line connecting the midpoints of the ends of the pile. If the bottom of the pile is out of sight, or cannot be seen because the pile cannot be dewatered, the shape and alignment of the pile shall be surveyed with a suitable instrument. No load shall be allowed on a pile which shows signs of buckling.

(3) Pipes shall be filled with concrete having a minimum compressive strength at twenty-eight days of three thousand pounds per square inch, and as further specified in Part 26. Concrete shall not be placed through water, except that the Commissioner may approve the use of a bottom-dump bucket for concreting a bottom section of a pile, provided that the pile is proven to be free of other materials.

(4) The center-to-center spacing of concrete-filled pipe piles shall be not less than two and one half times the outside diameter of the pipe.

(5) The load on concrete-filled pipe piles shall not exceed the allowable load determined in accordance with Section 2909, nor a load computed on the basis of stress in the concrete at twenty-two and one half per cent of the twenty-eight day strength, but not exceeding nine hundred pounds per square inch, and stress in the steel at eight thousand five hundred pounds per square inch, nor shall the load carried by the steel on this basis exceed one half the total load on the pile.

(c) H Piles

(1) Rolled steel H or other approved sections shall meet the requirements of the Specifications for Steel for Bridges and Buildings (A7–61T) of the American Society for Testing Materials. The minimum thickness of metal shall be four tenths of an inch. If piles are spliced, the splice shall develop one hundred per cent of the strength of the section.

(2) The center-to-center spacing of such piles shall be not less than two and one half times the width of the flange or the depth of the section, whichever is the greater.

(3) The load on such piles shall not exceed the allowable load determined in accordance with Section 2909, nor a load based on stress of seven thousand five hundred pounds per square inch on the cross-section.

(d) Concrete-Filled Pipes with Steel Cores

(1) Concrete-filled pipes with steel cores may be used only when the pipes can be firmly seated in bedrock of Classes 1 or 2, and shall be of sufficient diameter to permit the inspection of the bedrock socket. Pipe shall meet the requirements stated in Section 2913 (b) (1). If pipes are spliced, the splices shall be welded to develop one hundred per cent of the strength of the pipe.

(2) A socket, approximately of the inside diameter of the pipe, shall be made in bedrock of Classes 1 or 2 to a depth that will assure load transfer when computed for a bearing on the bottom surface of the socket in accordance with Section 2904 (b) and (c), acting together with a bond stress on the perimeter surface of the socket of one hundred pounds per square inch. Before placement of concrete, the socket and pipe shall be thoroughly cleaned and the rock inspected by a competent engineer or geologist satis-

factory to the Commissioner. This inspection may be performed by means of an underwater television camera, the position of which is readily controllable to permit thorough inspection of the exposed rock surface in the socket.

(3) The steel core shall consist of a structural steel member. The mating ends of the sections shall be spliced so as to safely withstand the stresses to which they may be subjected. The steel core shall be centered in the steel pipe and shall rest in a layer of cement grout on the bottom of the socket.

(4) The center-to-center spacing of such piles shall be not less than two and one half times the outside diameter of the pipe.

(5) Concrete shall have a minimum compressive strength of four thousand pounds per square inch at twenty-eight days. It shall be so placed that it shall fill completely the space between the steel core and the pipe. In case the socket cannot be kept free from inflow of water, the pipe shall be filled to its top with clean water before placing the concrete.

(6) The details of the design and the installation, including the cleaning and inspection of the socket, the placement of concrete under water or in the dry, the method of centering the steel core and all other phases of the work shall be submitted to the Commissioner for approval.

(7) The load on concrete-filled pipe piles with steel cores shall not exceed the allowable load determined in accordance with the provisions of Section 2913 (d) (2) nor that computed on the basis of nine hundred pounds per square inch on the area of the concrete plus eight thousand five hundred pounds per square inch on the net area of the steel pipe plus fifteen thousand pounds per square inch on the area of the steel core.

Sect. 2914. Composite Piles.—(a) A composite pile shall consist of a combination of not more than two of any of the different types of piles provided for in this part. The pile shall fulfill the requirements for each type and in addition the provisions of this section. The connection between the two types of piles shall be constructed so as to prevent their separation, to maintain their alignment, to support the load, and to be watertight where concrete must be placed subsequent to the driving. The design and the details of the connection shall be subject to the Commissioner's approval.

(b) The requirements of Section 2912 (c) (4) shall apply to the entire length of a pipe-composite pile.

(c) Wood-composite piles shall not be used for support of buildings exceeding two stories in height.

(d) The center-to-center spacing shall be governed by the larger of the spacings, required in this part, for the types composing the pile.

(e) The allowable load on composite piles shall be that allowed for the weaker of the two sections. For wood-composite piles the allowable load shall not exceed eighty per cent of that allowed for the wood section alone.

Sect. 2915. Bearing Tests.—(a) Whenever the allowable bearing value on bearing materials on single piles or groups of piles is in doubt, the commissioner may require bearing tests to be made and the results analyzed under the direction of a competent engineer approved by the commissioner.

(b) Before any bearing test is started, a sketch of the proposed test arrangement and an outline of the procedure to be followed shall be submitted to the commissioner and shall have his written approval.

(c) Bearing tests shall be conducted in the presence of an inspector, qualified by experience and training, and who is satisfactory to the commissioner. A copy of the test results obtained and a graph of the time-settlement curve for each increment of load and of the load-settlement and rebound curve for the entire test shall be submitted to the commissioner at the completion of each test.

(d) The load shall be applied by direct weight or by means of a newly calibrated hydraulic jack. The application of the test load shall be in steps equal to not more than one half the contemplated design load, to at least twice the contemplated design load, except as provided in Section 2915 (g). The unloading shall be in at least two steps, to the design load and then to zero load. During the loading cycle the contemplated design load and twice the contemplated design load shall be maintained constant for at least twenty-four hours and until settlement or rebound does not exceed two hundredths of an inch in twenty-four consecutive hours. The load for all other load steps including the zero load at the end of the test shall be maintained constant for a period of not less than four hours. Sufficient readings for each load step shall be made to define properly the time-deflection curve.

(e) Observation of vertical movement shall be made with dial extensometers graduated to at least one thousandth of an inch. The readings shall be sufficient in number to define the progress of the settlement or rebound and shall be referred to a beam, the ends of which rest on or are fixed to reliable supports located at least eight feet from the center of the test. In addition, the elevation of the supports shall be checked frequently with reference to a fixed benchmark. The entire measuring setup shall be protected against direct sunlight, frost action, and other disturbances that might affect its reliability. Temperature readings, both inside and outside the test enclosure, shall be made when the vertical movements are recorded.

(f) Additional Requirements for Soil Bearing Tests

(1) Bearing tests shall be applied at the elevations of the proposed bearing surfaces of the structure, except that the load may be applied directly on the surface of compacted granular material, Class 14.

(2) The excavation immediately surrounding an area to be tested shall be made no deeper than one foot above the plane of application of the test. The test plate shall be placed with uniform bearing. For the duration of the test, the material surrounding the test area shall be protected effectively against evaporation and frost action.

(3) For bearing materials of Classes 1 to 5, inclusive, the loaded area shall be not less than one square foot and for other classes not less than four square feet. For bearing materials of Classes 1 to 3, inclusive, the commissioner may permit compression tests on rock cores to be substituted for bearing tests. Each test specimen shall have a height not less than twice its diameter.

(4) The proposed design load shall be allowed provided that the requirements of Section 2904 are fulfilled and the settlements under the

design load and twice the design load do not exceed three eighths of an inch and one inch, respectively.

(g) Additional Requirements for Pile-Bearing Tests

(1) A single pile shall be load tested to not less than twice the design load. When two or more piles are to be tested as a group, the total load shall be not less than one and one half times the design load for the group.

(2) Provided that the load-settlement curve shows no sign of failure and provided that the permanent settlement of the top of the pile, after removal of all load at the completion of the test, does not exceed one half inch, the maximum design load shall be the load allowed in this part for the type of pile or one half of the maximum applied load, whichever is less.

(3) Whenever the soil conditions are such that substantial driving resistance and/or significant support of the pile test load is derived from soil strata overlying the intended bearing stratum, the results of the pile test shall be analyzed so as to evaluate the actual support furnished by the bearing stratum.

Sect. 2916. Settlement Analysis.—(a) Whenever a structure is to be supported by medium or soft clay (materials of Classes 11 and 12), the settlements of the structure and of neighboring structures due to consolidation of the clay shall be given careful consideration, particularly if there are large variations in thickness of the clay or the structure has substantial variation in net load at foundation grade. The commissioner may require a settlement analysis to be made by a competent engineer with specialized training and experience in soil mechanics in case the live and dead loads of the structure, as specified in Part 23, minus the weight of the excavation, induce a maximum stress greater than four hundred pounds per square foot at midheight of the underlying soft clay, computed by means of a procedure that is generally accepted in soil mechanics.

(b) The settlement analysis will be usually based on a computation of the net increase in stress that will be induced by the structure and realistically appraised live loads, after deducting the weight of excavated soil and other loads under which the clay was fully consolidated. The appraisal of the live loads may be based on surveys of actual live loads of existing buildings with similar occupancy. The soil compressibility data may be derived on the basis of one or more of the following data:

(1) A review of settlement records and behavior of other buildings in Greater Boston having similar subsoil profiles.

(2) Consolidation tests on undisturbed specimens with a diameter of at least two and one half inches. The report shall include a description of the method of sampling and of the quality of the samples.

(3) Consolidation test data from other projects in Greater Boston where the clay is found to be similar when compared on the basis of the natural water content and the liquid and plastic limits.

(c) Should the analysis indicate that the settlements would cause excessive stresses in the structure or would impair its usefulness, the design of the foundation and/or the superstructure shall be modified so that the anticipated settlements will be reduced to tolerable values.

PART 30.

FIRE EXTINGUISHING APPARATUS.

SECTION

***Section 3001. Fire Extinguishing Apparatus Required.**— (a) The owner of a building in which fire extinguishing apparatus is to be installed, altered or repaired (except repair of leaks and other minor repairs) pursuant to the requirements of this part, or connected to the water supply of the city of Boston, shall first make application to the building commissioner and obtain a permit therefor, in the manner specified in section ten of Part 1 and following sections relating to permits.

(b) Fire extinguishing apparatus shall be installed in buildings where specified in Parts 3 to 12, inclusive. The commissioner shall require automatic sprinklers in the basement or basements of pre-code buildings of occupancies of Groups E and F or of either of the two combined with occupancies of Groups H or I, when in his judgment public safety demands such protection.

(c) Such fire extinguishing apparatus shall conform to the requirements of this part and to such additional requirements as are specified in Parts 3 to 12, inclusive.

(d) All devices used in connection with fire extinguishing systems shall have the approval of a recognized testing laboratory and the approval of the commissioner or shall comply with the recommendation of the National Fire Protection Association.

[**As amended by Ord. 1943, ch. 8*]

Sect. 3002. Fire Department Standpipes.— (a) A fire department standpipe shall consist of a vertical pipe with fire department connection and outlet valves with connections for hose at convenient points in a building, by means of which the fire department may distribute water through the building to hose to be attached by the fire department for extinguishing a fire and protection against fire in an adjoining building.

(b) Fire department standpipes, where required, shall be of such number and so located that a stream from a nozzle on not more than one hundred feet of hose connected to a standpipe can be played upon every part of each story, assuming the stream to reach fifty feet from the nozzle.

(c) Fire department standpipes shall be not less than five inches in internal diameter throughout, and in buildings higher than ninety feet, or where the standpipe has a roof outlet, not less than six inches.

(d) Every fire department standpipe shall extend to every story of the building and above the roof unless the requirement of a roof outlet is waived by the commissioner. Such standpipe shall be located in a stair enclosure or other approved location and shall have, in every story above the first, an outlet two and one half inches in inside diameter threaded for standard fire hose coupling, and an approved angle globe valve. The outlet above the roof shall have two such hose connections, each with a valve. Hose outlets shall be not more than five feet above the floor, roof or stair landing. Neither the standpipe, outlet nor valve shall project within the width required for a stairway as an exit. Convenient to every roof outlet shall be provided and properly stored not less than fifty feet of approved two and one half inch linen hose and a tapered nozzle with one and one eighth inch smooth orifice.

(e) Every fire department standpipe shall have a fire department connection in an exterior wall of the building, fronting on a street, in an approved location not less than ten inches nor more than forty-eight inches above the sidewalk or ground. Two or more standpipes may have a common fire department connection. Where a building is required to have two or more fire department standpipes and faces on two streets it shall have two fire department connections remote from one another. The fire department connection shall be of approved design, shall have two couplings and if it serves two or more standpipes, shall have three couplings of not less than two and one half inches inside diameter threaded to receive standard city of Boston fire hose, and protected by approved caps.

(f) Where a building contains two or more fire department standpipes and two or more fire department connections, they shall be cross connected, but the commissioner may waive this requirement subject to such condition as he may in any case specify. Each fire department standpipe connection shall be marked by a cast bronze or brass plate embossed to indicate its connection to a standpipe.

(g) A fire department standpipe shall be connected to an adequate source of water supply and if subject to freezing shall be equipped with an approved control valve. An approved check valve shall be installed in the water supply pipe which will prevent water from the fire department connection from backing up in the supply pipes, and a check valve and automatic drain shall be installed between the standpipe and the fire department connection to prevent water from reaching a point where it would freeze.

(h) For protection against fire during construction, in a building required to have one or more fire department standpipes, they shall be installed with fire department connection and extended upward with the building, always reaching within one story of the highest constructed floor. During construction of the building, such standpipes shall be connected to an approved source of water supply and the outlets thereof shall be provided with hose and nozzles as required by the commissioner. Water shall be kept turned on in such standpipes during construction except in freezing weather and when the pipe is being extended. The shut-off valve shall be accessible and the standpipes in readiness for use at all times.

***Sect. 3003. First Aid Standpipes.**— (a) A first aid standpipe shall consist of a pipe or system of pipes connected to an adequate source of water supply, with valves, hose connections, hose and nozzles at convenient points inside the building for use of the occupants in extinguishing a fire.

(b) Where first aid standpipes are required they shall have hose stations in every story in such number and so located that a stream from a nozzle on the length of hose connected to an outlet can be played on every part of the story required to have such protection, assuming the stream to reach twenty feet from the nozzle. Pipes shall be so located as to be safe from injury by frost or otherwise.

(c) The risers of first aid standpipes shall be not less than two and one half inches internal diameter. Branches to single hose stations shall be not less than one and one half inches.

(d) A first aid hose station shall consist of an angle globe valve, threaded hose coupling, not more than fifty feet of approved linen hose, all one and one half inches in diameter, and a tapered nozzle with one half inch smooth orifice, attached, ready for use and mounted in an approved rack or reel, preferably in a cabinet. The valve and hose shall be not over five feet above the floor.

(e) First aid hose stations shall be located in corridors or other approved locations and shall be visible and accessible at all times.

(f) A fire department standpipe may serve as piping for a first aid standpipe if it is connected to an adequate water supply as provided in section thirty hundred and two but there shall be no interference between first aid hose stations and fire department outlets.

[**As amended by Ord. 1943, ch. 8*]

†Sect. 3004. Piping for Standpipes. — (a) Pipe for fire department or first aid standpipes shall be of wrought iron or steel of standard weight except that extra heavy pipe and fittings shall be used where the normal water pressure may exceed one hundred and seventy-five pounds per square inch.

(b) Piping shall be connected by screw fittings, flanges or unions; right and left fittings shall not be used. Fittings for changes in direction in pipes more than two inches in diameter shall be standard fittings. Reduction in pipe size shall be made by reducing fittings.

[*†As amended by Ord. 1943, ch. 8*]

‡Sect. 3005. Automatic Sprinklers. — (a) Where automatic sprinklers are required, the system of sprinklers and piping shall be designed to spray walls, ceilings and every portion of the floor space in accordance with the requirements of this part, except that arrangement and placement of sprinklers in accordance with the requirements of the National Fire Protection Association or the National Board of Fire Underwriters, shall be accepted as meeting the requirements of Sections 3005, 3006 and 3007 of this code.

(b) Where ceilings are smooth and unbroken there shall be a sprinkler for approximately every one hundred square feet and the spacing in a line shall not exceed twelve feet.

(c) Where ceilings are of wooden joist construction the spacing of sprinklers shall not exceed eight feet at right angles to the joists nor ten feet parallel to the joists and sprinklers shall be staggered at third points of the spacing in lines at right angles to the joists.

(d) Where ceilings have beams not less than five nor more than twelve feet apart on centers, sprinklers shall be placed midway between beams not over twelve feet apart and with not more than one hundred square feet of ceiling for each sprinkler.

(e) Sprinklers shall be placed under all soffits, inclined surfaces, decks, tables, benches, shelving, mezzanines, balconies or other similar construction more than forty-two inches wide when fixed against walls and more than sixty inches wide when such fixtures are clear of walls or partitions, within floor areas where sprinklers are required.

(f) Sprinklers shall not be placed closer than twelve inches from posts, walls, hangers or other vertical construction. Sprinklers, where required, shall be placed not further from walls and partitions than half the allowed spacing in the given direction, and under a joisted ceiling, not more than two feet.

(g) Sprinklers shall be placed preferably upright and the deflector shall be not more than ten inches nor less than three inches from the ceiling or soffit to be sprayed, the stream from the orifice perpendicular thereto.

(h) Sprinklers shall be of a type and construction approved by the commissioner and shall be designed to release at not more than seventy-five degrees Fahrenheit above the maximum temperature to be expected at the location where installed.

(i) Pipe for sprinkler systems shall be of wrought iron or steel, of standard weight and size, or other approved pipe, and shall have not less than the following inside diameters, depending on the number of sprinklers within one story and fire division supplied through each section of pipe.

Minimum Pipe Sizes for Automatic Sprinklers.

Number of Sprinklers.	Minimum Pipe Size (Inches).
1	$\frac{3}{4}$
2	1
3	$1\frac{1}{4}$
5	$1\frac{1}{2}$
10	2
20	$2\frac{1}{2}$
36	3
55	$3\frac{1}{2}$
80	4
140	5
200	6
400	8

(j) In buildings of Type I and Type II construction, the commissioner may allow not more than two hundred and fifty sprinklers to be supplied through a six-inch pipe and not more than five hundred sprinklers through an eight-inch pipe, in one story and fire division.

(k) Piping shall be connected by screw fittings, flanges, or unions; right and left fittings shall not be used. Fittings for changes in direction in mains and risers shall be standard fittings. Reduction in pipe size shall be made by reducing fittings.

(l) The system of sprinkler piping shall be well supported and pitched to drain completely. Piping and equipment shall be safe from injury by frost or otherwise.

(m) Sprinkler systems or portions thereof subject to freezing shall be equipped with approved dry pipe valves. The capacity of a system depending upon a single dry valve shall not exceed three hundred twenty-five gallons unless provided with a quick opening device, in which case the capacity shall not exceed five hundred seventy-five gallons. The air pressure maintained in a dry pipe system shall not exceed thirty-five pounds. Every dry pipe valve shall be equipped to give an alarm upon operation. The commissioner may allow that part of an automatic sprinkler system controlled by a cold weather valve to be shut off and drained in cold weather subject to such conditions as he shall in any case specify and the Fire Commissioner so notified in writing by the department.

(n) Nothing in this code shall be construed to prohibit the installation of a system of sprinklers containing twenty-five or less heads attached to the domestic water supply, provided the system is not mandatorily required elsewhere by this code.

[‡*As amended by Ord. 1943, ch. 8 and Ord. 1955, ch. 2*]

***Sect. 3006. Sprinkler Control.**— (a) The main supply pipe of a sprinkler system and each connection to the service main, if more than one, shall have a gate valve of approved indicator pattern with bronze stem, a check valve, test pipe and pressure gage, installed in approved locations. The main supply pipe of the system shall have a visible flow test pipe not less than one and one half inches in diameter with approved discharge. Valve stems shall not be placed below the horizontal and shall be within seventy-eight inches from the floor or shall be made accessible by permanent ladders fixed in place, or other approved means. Where sprinklers in two or more fire divisions are supplied through one or a set of two or more service connections, each fire division shall have a separate branch supply pipe with control valve and drain. Every required sprinkler system shall have a fire department connection, except that the commissioner may waive this requirement, subject to such conditions as he may specify, where the protected space is visible and directly accessible from a street or alley or where the number of sprinklers in any story and fire division does not exceed twenty-five.

(b) A fire department connection shall be of approved design and threaded for two and one half inch standard city of Boston fire hose and protected by approved caps. The pipe leading therefrom shall have a check valve and an automatic drain to prevent water from reaching a point where it would freeze.

(c) Every fire department sprinkler connection shall be marked with a cast bronze or brass plate embossed to indicate its connection to sprinklers.

(d) Every system of automatic sprinklers shall be connected to a permanent and adequate water supply as provided in section thirty hundred and seven.

(e) An inspector's test valve shall be installed at the top of every automatic sprinkler system.

(f) Where a main supply pipe serves automatic sprinklers in a basement or sub-basement concealed from view, or a remote building or a garage or part of a building, an approved sprinkler alarm shall be provided unless the commissioner shall waive this requirement.

(g) Neither goods, furniture, machinery or other materials or equipment shall be so placed as to interfere with the effectiveness of sprinklers nor shall sprinkler piping be used to support such materials or equipment.

[**As amended by Ord. 1943, ch. 8*]

†**Sect. 3007. Water Supply for Fire Extinguishing.**— (a) Water supply for required fire extinguishing apparatus shall be taken from the "high service" city water mains where available and, except when general service is permitted, shall be independent of the supply for sanitary, industrial or other purposes.

(b) In buildings where first aid standpipes or automatic sprinklers are required and where the city water supply, with a sufficient flow properly to supply the sprinklers, will not furnish a pressure of at least thirty-five pounds per square inch at the highest first aid hose station, and twelve pounds per square inch at the highest sprinkler, an auxiliary water supply for fire extinguishing apparatus shall be provided.

(c) An auxiliary water supply for fire extinguishing apparatus shall consist of a storage tank or a fire pump or both. A storage tank shall be either gravity or approved pressure type.

(d) A gravity storage tank shall have a capacity not less than five thousand gallons of water and the bottom of the tank shall be not less than twenty feet above the highest sprinkler or hose outlet. The tank and connected pipes shall have protection from freezing.

(e) A pneumatic pressure storage tank of such capacity (not less than thirty-five hundred gallons of water) and design, and with such automatic pumping equipment as will furnish as much water, at the same pressure, at the upper outlets of the system, as the gravity storage tank specified in paragraph (d) of this section, may be substituted therefor with the approval of the commissioner.

(f) A fire pump, to serve as an auxiliary water supply, shall be automatically controlled, shall be connected to the city mains and shall be capable of delivering water at the rate of twenty gallons per minute for each sprinkler up to fifty in any one story and fire division, against a head sufficient to furnish a pressure of twelve pounds per square inch at the highest sprinklers and of thirty-five pounds per square inch at the highest outlets of connected

standpipes in the building and shall be of a type satisfactory to the commissioner. A fire pump shall be connected to a permanent, reliable and approved source of power.

(g) Auxiliary water supply equipment shall have all necessary approved gate and check valves. Motors and other electrical equipment shall be enclosed, or protected by a hood and by a grille or partition of incombustible material.

[†*As amended by Ord. 1943, ch. 8*]

Sect. 3008. Portable Fire Extinguishers.— (a) A portable fire extinguisher shall consist of a container holding not less than two and one half gallons of extinguishing liquid so arranged and equipped that pressure may be generated and the contents discharged through a hose and nozzle; or a portable extinguisher of other type approved as equal thereto by the fire commissioner. The design and construction of portable fire extinguishers shall be approved by the fire commissioner.

(b) Portable fire extinguishers, where required, shall be mounted in corridors or other approved locations generally visible to the occupants of the building. Where they are placed in cabinets they shall be visible and the doors shall be unlocked or of glass which can be broken to give access to the extinguisher in case of fire.

(c) Portable fire extinguishers shall be discharged and recharged as often as shall be generally required by the fire commissioner for extinguishers of each type, and shall be recharged at once after use.

‡Sect. 3009. Inspection and Tests of Fire-Extinguishing Apparatus.— (a) Every system of automatic sprinklers and all parts thereof shall satisfactorily meet a pressure test of two hundred pounds per square inch and when water pressure is over two hundred pounds it shall be tested to fifty pounds above the highest static pressure.

(b) Standpipes and all parts thereof except hose shall satisfactorily meet a pressure test of two hundred and fifty pounds per square inch at ground level.

(c) First aid hose and other hose required for extinguishing purposes shall satisfactorily meet a pressure test, unless this requirement is waived by the building commissioner, in his presence, when first installed, and shall be thoroughly dried before it is hung in racks or reels.

(d) All required fire extinguishing apparatus, except as provided in section three thousand and eight, shall be inspected at least once each year and such tests shall be made as the building commissioner shall require. Defective hose and other defective parts shall be replaced without delay on order of the building commissioner.

(e) Piping shall not be concealed until tested and approved.

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 3010. Access Panel for Fire Extinguishing Apparatus.**— Where basement or cellar space below the ground floor of a store is used for storage purposes of any description access panels shall be provided in openings incorporated in the ground floor construction for use of fire department.

Each access panel opening shall be a minimum of ten inches square and provided with a removable cover of suitable strength to receive the live load for which the floor is designed. This removable cover shall be easily distinguishable from the rest of the floor. One such opening shall be located ten feet in from the main entrance door to store in line perpendicular to door. There shall be additional access panel openings in the same continuous line as the initial installation every twenty feet or portion thereof so that each opening shall provide provisions for fire extinguishing apparatus to cover each four hundred square feet of floor space. Where finished material of floor would cover or conceal access panel such covering shall be painted red directly over each opening.

Where ceiling material is provided on the under side of ground floor construction the access panel openings shall be provided with a breakable glass seal located below the removable cover. This glass seal may be located at the level of the ceiling, if above the level of the ceiling the four sides of the panel opening between the ceiling and the removable cover shall be finished with the materials joining the ceiling proper, or equivalent fire-resistive material.

The above requirements shall not apply if the basement or cellar is equipped with an approved automatic sprinkler system.

[**As amended by Ord. 1943, ch. 8*]

PART 31.

PLUMBING.

[*All heading as amended by Ord. 1943, ch. 8*]

*Section 3101. **Plumbing in Buildings.**— (a) Every building where people live, work or assemble shall have a supply of pure and wholesome water and a drainage system.

(b) Every building shall have such toilet accommodations and plumbing fixtures as are specified in Parts 3 to 12, inclusive, of this code or as required by any Massachusetts State Law or Regulation. If not so covered, to be as directed by the Building Commissioner or Health Commissioner of the City of Boston.

(c) Plumbing fixtures shall not be installed in rooms which do not conform to the requirements of this code.

(d) A permit to install, alter or repair plumbing shall not be issued unless the work is to be performed under the supervision of a master plumber, licensed under chapter one hundred and forty-two of the General Laws and registered by the Commissioner. An application for a permit for plumbing shall be signed as provided in section one hundred and ten of this code by a licensed and registered master plumber.

(e) Every master plumber holding a certificate issued in accordance with section three of chapter five hundred and thirty-six of the Acts of nineteen hundred and nine, section two of chapter five hundred and ninety-seven of

the Acts of nineteen hundred and ten or chapter five hundred and eighteen of the Acts of nineteen hundred and twelve, or licensed under chapter one hundred and forty-two of the General Laws, and has a business address in Boston or does business in Boston, shall personally register his name and business address with the Commissioner each year on or before the fifteenth day of May. He shall give the Commissioner immediate notice of any change in his business address.

[**As amended by Ord. 1943, ch. 8*]

†**Sect. 3102. Definitions Pertaining to Plumbing.**— For the purpose of this part of the code the words and terms defined in this section shall be construed as so defined except when qualifying words or the context clearly indicate that another meaning is intended.

Plumbing.— Plumbing is the art of installing in buildings the pipes, fixtures and other apparatus for bringing in the water supply and removing liquid and water-carried wastes; also, the system of pipes, fixtures, and other apparatus installed in buildings for distributing the water supply and for the disposal of liquid and water-carried wastes, including valves, traps, soil, drain, waste and vent pipes.

Plumbing System.— The plumbing system of a building includes the water supply distributing pipes; the fixtures and fixture traps; the soil, waste and vent pipes; the storm water drainage; with their devices, appurtenances, and connections all within or adjacent to the building.

Master Plumber.— A plumber who is licensed under chapter one hundred and forty-two of the General Laws as a Master plumber having a regular place of business and who, by himself, or journeyman plumbers in his employ, performs plumbing work.

Journeyman Plumber.— A person who is licensed as a journeyman plumber under chapter one hundred and forty-two of the General Laws and who installs plumbing in the employ and under the direction of a master plumber.

Battery of Fixtures.— A group of fixtures of one type, at the same level, not less than three in number.

Branch.— That part of a system of piping which extends from the main to a fixture or fixtures and which serves to connect to the main the fixtures which are not directly connected thereto.

Building Drain.— That part of the lowest horizontal piping of a building's drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls and extends to a point ten feet outside the inner face of the exterior walls.

Indirect Waste Pipes.— A waste pipe which is not directly connected to the drainage system but discharges into an open sink or other fixture.

Length of Pipe.— The developed length of pipe and fittings as connected, measured along the center line.

Main.— A general term signifying the principal line of a system of piping from which branches extend to fixtures.

Plumbing Fixture.— A receptacle or outlet intended to receive and discharge water, liquids or water-carried wastes into a drainage system either

directly or indirectly or to some other place that the Building Commissioner may approve.

Repair of leaks.—Such repairs as are necessary to protect property but do not involve change in construction.

Soil Pipe.—A pipe which conveys the discharge of water-closets, with or without the discharge of other fixtures, to the building drain.

Stack.—A general term for vertical line of soil, waste or vent piping.

Trap.—A fitting or device so constructed as to prevent the passage of air or gas through a pipe without materially affecting the flow through it of sewage or waste water.

Trap Seal.—The vertical distance between the crown weir and the inver of the trap outlet.

Vent Pipe.—A pipe provided to ventilate a drainage system and to prevent back pressure and trap siphonage.

Waste Pipe.—A pipe which receives the discharge of any plumbing fixture except a water closet, and conveys it to the building drain or to a soil pipe.

Water Distribution Pipe.—A pipe which conveys water from the water service pipe to or from a faucet, valve or any piece of equipment requiring water.

Water Service Pipe.—The water supply pipe from the City main to the building served.

Cross Connection.—Any connection whereby the potable water supply may become contaminated by any other substance or liquid.

[†*As amended by Ord. 1943, ch. 8*]

‡**Sect. 3103. The Drainage System.**—(a) The entire drainage system shall be so designed, constructed and maintained as to dispose of sewage and liquid wastes with velocities of flow that will avoid the deposit of solids and prevent clogging the pipes. The drainage pipes shall be so designed, constructed and supported as to be free from leakage of water, air or gas through defective materials, imperfect connections, corrosion, settlement, vibration, temperature changes, freezing or other causes. The entire system shall drain completely. No cement joints nor connections between iron and cement or tile pipe or brick drain shall be made within any building.

(b) The plumbing drainage system of every building shall be separately and independently connected, outside of the building to the public sewer if such sewer is accessible, to an approved private sewer or, if a sewer is not accessible, to an approved cesspool or septic tank; except that two or more buildings may have a common sewer if approved by the Building Commissioner and the Commissioner of Public Works. Sewage discharge into a cesspool shall have such treatment as the Commissioner and the Health Commissioner shall require.

(c) No substances which will clog the drains, produce explosive mixtures or injure the pipes or their joints shall be allowed to enter the drainage system or the sewer.

(d) Steam, vapor, and water at a temperature above one hundred and thirty degrees Fahrenheit shall not be discharged into the sewer. The

blow-off of boilers, steam exhaust or drip, or hot water from any other source destined to be discharged into a sewer shall first be condensed and cooled to one hundred and thirty degrees Fahrenheit in a blow-off tank or other approved device of which the size, arrangement, location, venting and all connections shall be subject to the approval of the Commissioner and the Commissioner of Public Works.

(e) A blow-off tank of approved design and connections, connected to one or more high pressure boilers shall have a capacity not less than thirty per cent of the largest boiler to which it is connected. Every blow-off tank shall have a vapor pipe not less than two inches in size extending above the roof and above any window within fifteen feet.

(f) Where a drainage system may be subjected to back flow of sewage suitable provision shall be made, by means of a gate and check valve or otherwise approved device, controlling fixture branches subject to back flow from the main drain.

(g) The building drain shall have a Y-branch fitting with an end cleanout or with an iron stopper near the point where it leaves the building. The cleanout shall be in a straight line with the drain as it passes through the wall. The drainage system shall have an adequate number of cleanouts so arranged that any stoppage in the pipe can be readily cleared. Cleanouts in drains under ground shall be made accessible. Other cleanouts shall be so located as to be accessible or to be made accessible through removable panels or otherwise.

(h) A building drain shall not be smaller in any portion than the largest soil or waste pipe or stack entering the drain.

(i) Stable fixtures and their drainage piping shall be installed in a manner approved by the Commissioner.

(j) A building drain shall have a fall of not less than one-eighth inch per foot of run and its size shall not be less than required for the fixtures which discharge through it as provided in the following table in accordance with the number of fixture units assigned to each type of fixtures as specified in section thirty-one hundred and fifteen. Schedule Paragraph E.

Maximum Number of Fixture Units for Pipe Size.

Pipe Line (Inches)	Drains.	Stacks.
1¼	1	1
1½	2.5	3.5
2	9	12
2½ — No Water Closets	21	27
3 — 1 Water Closet by permission	45	72
4	150	210
5	370	540
6	720	1050
8	1860	2640
10	3600	5250
12	6300	9300
15	11600	16800

(k) Changes in direction of building drains shall be made with Y-branches or long sweep fittings. Such changes in direction of building drains shall have full size cleanouts up to four inch in size and not less than four inch for sizes larger, at or near the change of direction and at or near the foot of all stacks. Cleanouts shall not be over fifty feet apart on straight runs. Drains shall not be laid in filled ground without adequate support to the building structure. Drain pipes passing under walls shall be free from stress.

(l) All other connections to the drainage system shall be made with Y-branches or sweep fittings with the exception of vertical soil or waste pipe connections which may be made with short pattern TY's. Tee connections may be used on vents only.

(m) Offsets in vertical soil, waste, vent and conductor stacks shall be made as direct as possible and short radius fittings shall not be used.

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 3104. Soil and Waste Pipes.**— (a) Soil and waste pipes from plumbing fixtures shall discharge into the building drain.

(b) Every building drain serving water closets or pedestal urinals shall have at least one four-inch diameter vent extension through roof. Branches of soil or waste pipes, if more than twenty feet long, shall be extended through roof or connected to vent stack undiminished in size, except that a two-inch waste stack may be connected at the bottom to a three-inch waste if the number of connected fixture units does not exceed eight.

(c) A horizontal branch of soil or waste pipe shall have a fall not less than one-eighth inch per foot of run.

(d) The maximum developed length of one and one half inch or smaller waste pipe shall not exceed fifty feet.

(e) No soil pipe shall be less than four inches in size, except that a three-inch soil pipe may be used for one water closet, with the approval of the commissioner, where it is not practicable to use a four-inch pipe.

(f) No waste pipe where buried underground shall be less than three inches in size.

(g) In buildings more than one hundred and twenty-five feet high, soil stack shall be at least five inches, waste stacks serving slop sinks or urinals shall be at least four inches and waste stacks serving lavatories shall be at least three inches in size.

[**As amended by Ord. 1943, ch. 8*]

†Sect. 3105. Rain Water Drains.— (a) All rain water drains from roofs, including area drains and surface drains, shall be kept separate from the building drainage system of a building, except as provided in this section. Area drains and surface drains may be connected to the building drainage system or otherwise disposed of only with the approval of the commissioner.

(b) Where a storm water sewer is accessible rain water drainage shall be discharged therein. In locations where the commissioner shall indicate that storm water sewers may presently be laid, the main rain water drain shall extend at least ten feet from the inner face of the foundation wall and may there be connected to the building sewer. Elsewhere the rain water shall be

discharged into the building drain near the point where it leaves the building, or otherwise disposed of in such manner as not to flow upon a public way or neighboring land.

(c) A main rain water drain outside a building, except where a storm water sewer exists shall be laid not lower than four feet below street grade.

(d) Rain water leaders shall not project into a public way more than seven inches.

(e) All rain water piping shall have a fall of not less than one eighth inch per foot of run. The size of a rain water drain or leader branch shall be not less than as provided in the following table.

Maximum Horizontal Projection of Drained Area.

Pipe Size (Inches)	Area (Square Feet)
2	600
3	1750
4	3600
5	6300
6	8000
8	16000
10	25000
12	40000

When and where the rain water and sanitary systems are combined, the area of the combination drain pipe shall be not less than sixty-six and two-thirds per cent of the sum of the pipe areas discharged into it.

[†*As amended by Ord. 1943, ch. 8*]

‡**Sect. 3106. Indirect Wastes.**— (a) Drips from refrigerators, ice boxes or other containers in which food is stored, heated or cooled shall not be directly connected to soil or waste pipes or any other part of the drainage system, but shall discharge in open sight into an open fixture which shall have a supply of running water. Wastes of instrument sterilizers, aspirators, compressors, stills, vacuum and other similar equipment shall enter trap through a visible broken connection of not less than one and one half inches long. Trap to be located as close to the fixture as practicable.

(b) Indirect wastes discharging into open fixture from fish storage tanks, corn beef tanks, or window display tanks and similar equipment shall be a separate system and the end of the indirect waste shall be extended independently above the roof for ventilation.

(c) Each fixture and piece of equipment wasting into indirect waste pipes shall have separate traps.

(d) An indirect waste serving two or more fixtures or pieces of equipment shall be extended through the roof independently.

(e) Vapor vents, from sterilizers and other hospital equipment, where required shall be installed as a separate system terminating above the roof.

(f) Layouts of all indirect waste systems shall be submitted for approval to the building commissioner.

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 3107. Mechanically Discharged Drainage.**— (a) Floor drains, drips from machinery and other clean wastes approved by the commissioner, too low to drain by gravity to the sewer, may drain to an open sump or receiving tank and thence be discharged by mechanical means into the gravity drainage system. The discharge pipe shall be equipped with a check valve and shall be trapped with a deep seal trap.

(b) Where the whole or a part of a drainage system receiving the discharge of soil and waste pipes, other than those provided for in the preceding paragraph, is too low to drain by gravity to the sewer it shall drain to a closed iron sump or receiving tank and thence be discharged by mechanical means, automatically operated, into the gravity building drain or directly to the sewer. Such closed iron sump or receiving tank shall form part of the drainage system and shall be made tight and be tested as provided for other parts of the system. It shall be vented by means of an independent vent pipe not less than four inches in size extended through the roof as provided for vent stacks in section thirty-one hundred and ten, or connected to a vent stack not less than four inches in size at least twenty feet above the tank, or may be properly connected to the vent stack of the fixtures discharging into the sump if such vent is four inch size or larger.

(c) The discharge pipe from a sewage ejector shall not be less than four inches in size and shall be fitted with a check and gate valve.

(d) The plumbing fixtures which drain to a closed sump or receiving tank for mechanical discharge shall have waste or soil pipes, traps and vent pipes as provided for in gravity drainage. Such vent pipes shall be extended independently through the roof or be connected to a vent stack not less than twenty feet above the tank, or at least above the rim or over-flow point of the lowest fixture of the gravity drainage system.

(e) Drainage discharged by mechanical means into the gravity drainage system within a building, as provided in this section, shall discharge into the top of the receiving drain.

(f) Where closed sumps for wastes other than sewage are used, they shall have a chamber vent not less in size than the size of the inlet.

[**As amended by Ord. 1943, ch. 8*]

†Sect. 3108. Traps. — (a) Except as otherwise provided in this section, the waste pipe of every plumbing fixture shall have a separate trap to prevent emission through the fixture of foul air from the drainage system. Such trap shall be placed as near the fixture which it serves as is practicable.

(b) Single tray or sink may be fitted with a one and one half inch trap. A two part or a three part tray may be considered as one fixture and shall be fitted with a trap, the outlet of which shall be not less than two inches in size. Two part tray, three part tray, combination of two trays and one sink

when close together, combination sink and tray, each of which may be considered as one fixture and shall be fitted with a trap, the outlet of which shall be not less than two inches in size. Where a two inch half S trap is used, the combined waste to the inlet side of the trap shall be not less than two inch in size. When placed on the same level the waste pipe from the traps of two fixtures of like type and used for the same purpose may be connected to the branch openings of a long pattern double TY type of fitting placed in an upright position and shall require no other vent than the continuation of the waste serving these two fixtures undiminished in size.

(c) The waste pipes from dishwashers or sinks discharging grease in a kitchen of a hotel, restaurant or club shall have individual grease traps of approved capacity and type or else shall waste into a master grease trap and system. When individual approved grease traps are used they shall be easy of access to open and clean and placed as near as practicable to the fixture which they serve.

(d) The waste pipe from every floor drain or other fixture from which, in the opinion of the commissioner, grease may be discharged in such quantity as to clog or injure the drain, shall have an approved grease trap. A master grease trap will be allowed in lieu of separate grease traps when separate system of drainage is installed for fixtures requiring a grease trap. The master grease trap must be in an accessible location for cleaning. Master grease trap will be required in lieu of separate grease traps on individual fixtures, when in the opinion of the building commissioner it is necessary, to protect the drainage system and public sewer from grease. When a master grease trap is installed, each fixture discharging into a master grease trap shall be fitted with individual one half S trap properly vented. Master grease traps shall be approved by the commissioner as to capacity and type.

(e) The waste pipe from every floor drain or other fixture from which gasoline, naphtha or other inflammable liquid may be discharged to a sewer shall have a special trap approved by the commissioner of public works so constructed as to prevent the passage of such liquids or gas into the sewer. Plans of approved type may be procured at the office of the commissioner. When a gasoline separator serves floor drains on the same level as the gasoline separator and each entering the gasoline separator independently and within fifteen feet they shall require no other than the chamber vent.

(f) The waste pipe from wash stand for vehicles shall have an approved trapped combination floor drain and sand arrestor not less than four inch in size.

(g) The waste pipe from an area drain or surface drain shall have a deep seal trap.

(h) Traps shall be installed in all conductor leaders terminating below the main roof, or roofs used for any purpose, other than weather protection. Separate traps may be omitted if main roof drain is properly trapped.

(i) Every trap installed shall be so located as to be accessible.

(j) Every trap shall have a water seal of at least one and one half inches. Deep seal traps shall have a water seal of at least four inches.

(k) All fixture trap cleanouts shall be water sealed.

(l) Slip joints or unions shall not be used on the outlets of traps.

(m) Threaded outlet connections on all screw traps shall be iron pipe size.

(n) Iron traps less than two inch in size shall not be used where concealed.

(o) Non-syphon trap shall only be used by special permission of the commissioner and when so used shall be of an approved type and shall have a depth of seal not less than four inches.

[†*As amended by Ord. 1943, ch. 8*]

‡**Sect. 3109. Venting.** — (a) The drainage system shall be so designed that there will be circulation of air in all pipes thereof and no danger of syphonage, aspiration or forcing of trap seals under conditions of ordinary use.

(b) Traps, except non-syphon traps where approved, shall be protected from syphonage or air pressure by separate vent pipes, not less in size than the outlet of the trap they serve, except as otherwise provided in this section.

(c) The trap for the fixture having the highest connection to a soil or waste stack need not have separate vent pipe if within five feet from the stack and the soil or waste pipe is not connected to the soil or waste stack below the invert of the trap, with the exception of closets and similar fixtures which shall be connected to soil or waste stack not more than eighteen inches below the weir of the group.

(d) The traps of a battery of water closets, pedestal and stall urinals and bed pan washers, may have, instead of separate vent pipes, a vent pipe connected to the common waste or soil pipe just before the branch from the fixture most remote from the waste or soil stack and between the first fixture and the soil or waste stack. If such a battery has more than six fixtures there shall be a similar vent pipe connection before the branch from every sixth fixture and in no case shall there be more than five fixtures between the vents. Vents shall not be less than four inch in size. This type of venting may be used only when the vertical distance between the water level of the trap and the top of the common waste or soil pipe is not more than twenty-four inches and where the developed length of the branch waste or soil pipe is not more than three foot six inches between the center line of the common waste or soil pipe and the water level of the trap. Water closets and pedestal urinals shall be considered one type. No other fixtures shall enter the battery system. The commissioner shall prepare explanatory sketches showing the method of construction described in this section.

(e) Single floor drains shall be separately vented unless otherwise noted. Groups of two or more floor drains discharging through separate branch waste pipes not more than fifteen feet long into four inch or larger main waste pipe serving floor drains only, may be vented on the outlet side of the end floor drain, by means of an extension of the main waste pipe undiminished in size as a vent pipe.

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 3110. Vent Pipes.**— (a) The vent pipes from traps and the extension of soil and waste pipes shall be extended upward through the roof

or connected to vent stacks extended through the roof. Waste and soil stacks shall be extended through the roof and for the purpose of this section, the portion of a waste or soil stack above the highest fixture connected to it shall be considered a vent stack.

(b) Vent pipes shall be connected at the bottom with a soil or waste pipe or with the building drain in such manner as to prevent accumulation of rust scale and properly to drip the water of condensation. The foot of all vent stacks shall be connected to soil or waste stack through a separate Y branch.

(c) Vent stacks shall be extended to a height of not less than two feet above the roof and not less than one foot above the top of any window within fifteen feet. Where a roof is to be used for purposes other than weather protection, vent stacks shall extend not less than seven feet above the roof and the arrangement shall be subject to the approval of the commissioner.

(d) No vent stack through roof shall be less than four inches in diameter from a point within the building.

(e) Two or more vent pipes may be connected together but such connection shall be above the fixtures served.

(f) Vent pipes shall not be connected to the trap or branched into the waste pipe except where a continuous vent is not practicable. Vent pipes shall be run as directly as practicable. Horizontal vent pipes when below the top of the fixture it serves shall be installed with the shortest possible horizontal run. The opening of these vents shall be above the center line of the waste pipe.

(g) The size of a vent pipe, up to and including two-inch shall not be less in size than the outlet of the trap it serves. Such vent pipe shall connect to the waste pipe not more than eighteen inches from the trap. The size of a vent pipe shall not be less than as provided in the following table depending upon the number of fixture units which it serves and the length of the pipe.

Pipe Sizes (Inches)	Maximum Number of Fixture Units	Maximum Length Feet
$1\frac{1}{4}$	.5	10
$1\frac{1}{2}$	3	25
2″	25*	60
3″	100	125
4″	250	250
5″	500	300
6″	1250	400
8″	2400	Not limited

*Note exception below.

In determining the length of a vent pipe the stack and branches shall be considered continuous.

(h) A vent pipe serving water closets, pedestal urinals, bed pan washers and service sinks shall not be less than two inches in size. Such two inch vent pipe shall not serve more than three fixtures of the above type and shall not be longer than forty feet.

(i) The size of a vent stack shall be at least one half of the diameter of the waste or soil stack served. Where soil stacks are installed, fitted with connections for future use, are four inch in size, a parallel vent stack not less than three inch in size with three inch branches shall be installed. The parallel vent stack shall be connected to the soil stack below the lowest proposed fixture.

(j) Where three or more vent stacks are connected near the top to a single pipe extending through the roof, the internal area of the combined stack shall be not less than one half the sum of the area of the stacks so connected.

(k) Every vent pipe shall be free from dips or sags and shall be so graded and connected as to drip back to the soil or waste pipe.

(l) Bow vents shall be installed only by permission of the commissioner and in accordance with his instructions and shall be dripped at its lowest point.

[**As amended by Ord. 1943, ch. 8*]

†**Sect. 3111. Buildings More than One Hundred Twenty-Five Feet High.**— (a) Vent stacks shall not be less than three inch in size.

(b) Vent stacks serving water closets, pedestal urinals, bed pan washers or service sinks shall be increased to at least four inches in size at a point eighty feet above the bottom of vent stack.

(c) Vent stacks shall not be connected to other vents or vent stacks but shall extend through the roof independently where practicable.

(d) Vent stacks including the upper portion of soil or waste stacks, three inches in size shall be increased to four inch in size from a point below the roof.

(e) 2″ Branch vents serving water closets, pedestal urinals, bed pan washers and service sinks shall not be more than thirty feet long and shall serve not more than three of the above fixtures. Branch vents for other fixtures shall comply with the table in section 3110.

[*†As amended by Ord. 1943, ch. 8*]

‡**Sect. 3112. Materials of Drainage System.**— (a) Waste, soil and vent pipe shall be of cast iron hub and spigot pipe, cast iron screw pipe, galvanized steel or wrought iron, lead, iron size brass or copper, except that cast iron screw pipe, and galvanized steel or wrought iron pipe shall not be used underground. In buildings of Group I Occupancy galvanized piping shall not be used for built-in waste piping in floor or wall construction.

(b) All sanitary and rain water drains within a distance of ten feet outside the inner face of the foundation wall shall be cast iron hub and spigot pip. coated with asphaltum or red lead.

(c) Waste and vent pipes, traps and fittings serving fixtures in chemical laboratories or used for the disposal of acid or other corrosive chemicals shall be of approved acid resisting materials. The arrangement of piping shall be approved by the commissioner. All plumbing fixtures in large chemical

laboratories shall have a separate system of drainage and vent piping independent of other drainage system of building. When diluting chamber is used individual vents for fixture traps in group fixtures may be omitted if main waste is extended through roof undiminished in size, and branch from main to fixture is not more than twenty-five feet. If branch waste to fixture is more than twenty-five feet the end of the branch shall be extended full size over roof or reconnected to main chemical vent stack.

The effluent from diluting tank may waste into the building drainage system.

The design and location of the dilution tank and arrangement of the piping shall be approved by the commissioner.

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 3113. Water Supply.**— (a) All water piping of every description supplying water from city mains to all plumbing fixtures and equipment with the exception of the distributing piping of hot water building heating system, intercommunicating piping between various pieces of apparatus of a boiler room plant, and engine room apparatus, shall be installed by a journeyman plumber licensed under chapter one hundred and forty-two of the General Laws under a permit issued to a registered and licensed Master plumber.

(b) No water distribution system to plumbing fixtures and equipment shall be installed until a plan submitted to the commissioner has been approved for a safe and adequate supply.

(c) Water supplied from city mains shall be distributed by a system of piping independent of water from any other source unless such source is approved by the health commissioner for drinking purposes.

(d) No connections to fixtures supplied with city water, or to supply piping thereof, shall be made from other pipes, piping systems, mechanical apparatus, equipment or device, directly or indirectly, in such manner that in the opinion of the health commissioner, and the building commissioner, the quality of the potable water may be adversely affected. No plumbing fixture, device or construction shall be installed which will provide a cross connection between a distributing system of water for drinking and domestic purposes and a drainage system, soil or waste pipe or sprinkler or process piping system so as to permit or make possible the back flow of sewage or waste or non-potable water into the water supply either by gravity, siphonage or pressure.

(e) The water service pipe and distribution pipes shall be of sufficient size to permit continuous ample flow of water to fixtures and equipment in all stories at all times.

(f) Where the water pressure is insufficient to supply all fixtures freely and continuously a house supply tank or pneumatic system shall be provided, adequate for the purpose. Such tank or system shall be supplied by city pressure through automatic controls, where necessary by power driven pumps.

(g) The over-flow pipe from gravity or house tank or drip pans shall be extended to drain into suitable plumbing fixture or be connected to rain

water leader. When connected to leader over-flow shall be fitted with deep seal trap and check valve. Over-flow pipe shall be at least twice the area of the water supply pipe feeding the tank.

(h) All plumbing fixtures shall be provided with a sufficient supply of water for flushing to keep them in a sanitary condition. Every water closet and urinal shall be flushed by means of an approved flush valve or individual tank of at least four gallons flushing capacity for water closets and at least two gallons for urinals, and shall be adjusted to prevent the waste of water. The flush pipe for water closet flush tanks shall be not less than one and one quarter inches in diameter and the water from the flush tanks shall be used for no other purpose.

(i) No plumbing fixture, mechanical apparatus, equipment or device shall be connected with building water supply distributing system through automatic flush valve, other valve or tank, unless such flush valve, valve or tank is located above the fixture or equipment being served.

All water closets, urinals, slop hoppers, bed pan washers, dish washers and other fixtures receiving their supply of water through flush valves, shall have an approved type of vacuum breaker installed between flush valve and fixture or equipment being served. The vacuum breaker, shall be installed at a minimum distance of four inches from bottom of vacuum breaker to the top of fixture or equipment.

Fixtures or equipment having water supplied through submerged inlets shall be fitted with an approved type of vacuum breaker installed in the water supply line between the water supply control valve and the fixture or equipment being served and at no less than four inches above the top of the device being served.

All vacuum breakers shall be made easily accessible for observation, inspection and repairs.

For all fixtures and devices supplied through faucets or equivalent, such faucets shall be located above the top of the receptacle being served and with a minimum approved air gap between the end of supply nozzle and the top of receptacle.

(j) An accessible shut-off shall be provided on the main water distribution pipe just inside the foundation wall which shall control the water supply to the entire building. In structures, other than residences occupied by one family, accessible shut-offs shall also be provided which shall separately control the water supply for each flat, apartment, suite, or store of a building.

(k) Supply pipes of ferrous material shall not be installed under bath room floors in Group I occupancy.

No pipe or fittings that have been used for other purposes, nor second hand pipe or fittings of objectionable origin shall be used for distributing potable water.

(l) Water supply branch of lead, copper or brass to individual fixture shall not be less than three eighths inch size; of other material, not less than one half inch size. Water supply branch connected to a flush valve shall not be less than one inch size for water closet, pedestal or blow-out urinal and not less than one half inch size for other type of urinal.

Slip joints on water supply system shall not be used on the pressure side of fixture faucets or cocks.

[**As amended by Ord. 1943, ch. 8*

†**Sect. 3114. Hot Water Supply.** — (a) Hot water storage tanks shall be installed and connected by a licensed plumber under a permit issued to a registered and licensed master plumber.

(b) No hot water storage tank or other vessel in which water is to be stored or heated under pressure shall be installed or connected unless there are plainly stamped thereon in the metal, the maker's business name, its capacity in terms of Massachusetts standard liquid measure, maker's guarantee of pressure to which tank has been tested, maximum working pressure at which tank may be installed. The test pressure shall not be less than two hundred pounds hydraulic or hydrostatic pressure. The working pressure shall not be greater than forty-two and one half per cent of the guaranteed test pressure. No tank shall be installed at pressure greater than its working pressure.

(c) Every hot water tank or boiler hereafter installed, or relocated to which a heating device or appliance is connected, in which water is to be heated under pressure above fifteen pounds per square inch, shall be equipped with pressure relief, temperature relief and vacuum relief valves placed in an accessible location. These valves are to be placed on the hot water tank or boiler, or on the piping to or from the hot water tank as hereinafter described. No make of such valves shall be used unless approved by the building commissioner.

(d) **Individual Pressure Relief Valves:** Pressure relief valves shall have a disc which is kept closed by a spring on which tension can be varied to take care of different static pressures. The valve shall be set to open at a pressure not more than fifteen pounds higher than the working pressure stamped thereon in the metal of the tank or boiler. Valve may be placed on the hot or cold water supply above tank or boiler between control valve and tank or boiler.

(e) **Temperature Relief Valves:** Fusible Plug Type: Temperature relief valves of the fusible plug type shall be placed in a separate tapping in the shell of the tank or boiler within twelve inches of the top of the tank or boiler, or on the hot water flow pipe from tank or boiler. Where temperature relief valve is installed on the flow pipe, it shall be within eight inches, developed length, from the top of the tank or boiler and the fusing element shall be installed within two inches of the flowing water. The fusing element of the individual temperature relief valve shall fuse and begin to discharge hot water from the tank or boiler when the temperature of the water has reached a point not greater than two hundred and twelve degrees Fahrenheit.

(f) **Temperature Relief Valves:** Automatic Type: Temperature relief valves of the automatic type shall be placed in a tapping in the shell of the tank or boiler within twelve inches of the top of the tank or boiler, or shall be installed on the flow pipe from the top of the tank or boiler within eight inches, developed length, from the top of the tank or boiler and shall be

installed within two inches of the flowing water, and shall begin to discharge hot water from the tank or boiler when the temperature has reached a point not greater than two hundred and twelve degrees Fahrenheit and shall close tight when the temperature of water in tank or boiler has been reduced approximately thirty-five degrees lower than the relief temperature. The capacity of the temperature relief valve shall be governed by the maximum heating rate of the hot water heater. A differential of ten degrees plus or minus from closing temperature will be considered satisfactory.

(g) **Vacuum Relief Valves:** Vacuum relief valves shall be constructed so as to relieve vacuum instantly at a minus pressure not greater than one inch of vacuum in the tank or boiler.

The relieving element of the vacuum valve shall be of materials that will not corrode or hold fast to the seat after prolonged use.

The valve shall not leak under an internal pressure of from ten pounds to one hundred and twenty-five pounds per square inch.

Valves of the ball check type shall not be approved.

Vacuum relief valves shall be placed on the cold water supply pipe to tank or boiler above top of tank or boiler.

Where cold water supply enters below the top of tank or boiler from a water supply located below the tank or boiler, the supply pipe shall rise to above the top of tank or boiler forming a loop and the vacuum valve shall be placed on top of loop above tank.

(h) All internal parts of pressure relief valves, fusible plug valves or automatic relief valves shall be of materials impervious to corrosion equal to eighty-five per cent copper, five per cent tin, five per cent lead and five per cent zinc, except fusing element.

(i) The casing of each valve shall be stamped, or have a metal strap attached to it stating in plain lettering the manufacturer's name, type of valve, limit of pressure relief settings, capacity of B. T. U. discharge and melting point of fuse plug.

(j) Pressure relief, temperature relief valves shall have the discharge end of the valves extended to an open fixture or to the basement of the building near to the floor if open fixture is not available.

(k) The valve shall be designed so that it will discharge water at a rate that will prevent any increase in the water temperature in the tank or boiler when the valve is in operation.

(l) The area of the discharge pipe from the relief valves shall not be less than the area of the valve. When two or more valves are connected to the same discharge pipe the pipe area shall not be less than the aggregate area of all the valves it serves. The discharge pipe shall be of brass or copper and pitch down from the valve it serves to prevent the trapping of water.

(m) Combination pressure and temperature relief valves may be used if they comply with all of the requirements as described for individual valves.

Temperature relief of the fusible plug type or automatic type will be acceptable.

(n) In all hot water tanks or boilers having a capacity of one hundred gallons or larger the pressure relief valve shall be fitted with a lever type handle to allow for periodic tests by inspectors.

(o) **Tankless Hot Water Heaters:** All tankless heaters connected to or part of heating boilers operated at more than five pounds pressure shall be equipped with approved type pressure relief valve. Pressure relief shall not be set more than one hundred and twenty-five pounds. Pressure relief valve shall be placed between control valve and heating coil.

(p) **Cistern Pressure Hot Water Tank:** Cistern pressure hot water tanks in which water is to be heated or stored shall have an expansion pipe extended from the highest point of the hot water system or from the top of the hot water tank, over the top of the supply tank that supplies the water to the hot water tank. No valve of any description shall be installed on the expansion pipe between the top of the hot water tank and its opening above the supply tank. The expansion pipe shall be of non-ferrous material.

(q) No check valves or non-by-pass pressure regulators shall be installed on the cold water supply to the hot water tank.

(r) When check valve or pressure regulator is installed the installation shall be approved by the Commissioner.

(s) No shut off valve shall be installed to prevent the circulation of water between the hot water tank and its heater, unless approved by the Commissioner.

[†*As amended by Ord. 1943, ch. 8*]

‡**Sect. 3115. Plumbing Fixtures and Units.**—(a) The orifice of the jet of every drinking fountain shall be placed above the rim of the fixture and shall throw an inclined stream. The water supply issuing from the orifice shall be of sufficient volume and height so that persons using the fountain need not come in direct contact with the orifice.

(b) Earthenware integral fixture traps shall have a flange on the fixture bolted to a flange on the end of the waste or soil pipe, the joint made tight with red or white lead or other approved compound, or with an approved gasket. A rubber gasket shall not be used. If the waste or soil pipe is of lead the flange on its end shall be of heavy brass soldered to the lead pipe; if of cast iron, the flange shall be of extra heavy cast iron caulked or screwed to the pipe. Such floor flanges for water closets, slop sinks or urinals shall be not less than three sixteenths inch thick. The ioint between flange and lead bend or start shall be examined by the Plumbing Inspector before the fixture is permanently set.

The waste or soil pipe to floor or wall outlet earthenware fixtures where used with a flange shall terminate at the finished floor or wall line.

Brass floor or wall flanges shall be of heavy pattern with no openings except for bolts and waste openings.

Lead closet bends or starts shall be limited to one connection, which shall be used for vent only, except in replacement of the closet bend or start existing wastes may be connected to new bend or start.

The lead bend or start shall be connected to the drainage system by means of a heavy bell shaped brass ferrule with full size wiped solder joint.

(c) No trough or multiple type urinal or water closet shall be installed except for exterior temporary use, unless approved by the commissioner.

(d) Minimum size of floor drain shall be 3″ except as noted for refrigerator wastes in table below.

(e) The following schedule shall be used for determination of the minimum diameters of fixture traps and the equivalent unit of value.

Fixture.	Trap Size (Inches.)	Unit Value.
Bath Room Group — 1 W. C. — 1 Lav. — 1 Bath Tub..............		6.0
Bath Room Group — 1 W. C. — 1 Lav. — 1 Bath Tub — 1 Shower Stall		7.0
Baby's Bath Slab..	1½	2.0
Bed Pan Sterilizer..	3	5.0
Bed Pan Washer..	3	5.0
Combination Sink and tray.....................................	2	2.0
Commercial laundry tray — Revolving type — 7½ gallon per minute discharge..		4.0
Dish washer — Hotel — Restaurant — Club.......................	2	6.0
Dental Cuspidor...	1½	0.5
Drinking Fountain...	1½	0.5
Floor Drain — Unrated Fixtures — for each gallon per minute discharge		2.0
Floor Drain — For Refrigerator Wastes — Minimum Trap Size 2″.....		0.5
Foot Bath...	1½	2.0
Instrument Sterilizer...	1½	0.5
Laundry Tray..	1½	2.0
Lavatory..	1½	1.0
Pedestal Urinal...		5.0
Bar Sink..	1½	2.0
Fish Sink...	2	4.0
Kitchen Sink..	1½	2.
Kitchen Sink — Hotel — Restaurant — Club......................	2	4.0
Laboratory Sink...	1½	2.0
Lunch Counter Bar Sink — Combination of Same..................	2	4.0
Pot Sink..	2	4.0
Scullery Sink — Hotel — Restaurant — Club.....................	2	4.0
Sewage Ejectors — For Each 25 Gallons per Minute Discharge........		50.0

Fixture.	Trap Size (Inches.)	Unit Value.
Shower Stall	2	4.0
Slop or Service Sink — Group H and I Occupancy	2	4.0
Slop or Service Sink	3	5.0
Stall Urinal	2	4.0
Surgeon's Sink	1½	2.0
Restaurant Glass Sink	1½	2.0
Restaurant Silver Sink	1½	2.0
Vegetable Sink — Hotel — Restaurant — Club	2	4.0
Wall Hung Urinal	2	4.0
Water Closet		5.0
Water Still	1½	0.5
Utensil Sterilizer	1½	0.5

Unit value of fixtures not contained in the above table shall be determined by the commissioner.

[‡*As amended by Ord. 1943, ch. 8 and Ord. 1955, ch. 2*]

***Sect. 3116. Cast Iron Pipe.**—(a) Cast iron pipe shall be sound, cylindrical and smooth, free from cracks, sand holes and other defects, of uniform thickness and of the grade known in commerce as extra heavy. If buried underground it shall be coated with asphaltum or red lead; otherwise, it shall be uncoated until inspected and approved. The weight of cast iron pipes per length, in lengths to lay five feet, shall not be less than listed in the following table:

MINIMUM WEIGHTS OF CAST IRON PIPE.

Diameter (Inches)	Weight per Length (Pounds)	
	Single Hub.	Double Hub.
2	25	26
3	45	47
4	60	63
5	75	78
6	95	100
8	150	157
10	215	225
12	270	285
15	375	395

(b) Fittings for cast iron hub and spigot pipe shall be of the weight known in commerce as extra heavy and shall comply with the weights and dimensions to the cast iron soil pipe fittings as approved by American Standards Association.

(c) Joints in cast iron hub and spigot pipe shall be made with hemp or oakum and molten lead run full and caulked to make gas and water tight without the use of wax or any compound.

(d) No double hub or sleeve shall be used on cast iron drain, soil, waste, or vent pipes. The drilling, tapping or welding of cast iron, hub and spigot drain, waste, soil or vent pipes, and the use of saddle hubs or bands are prohibited.

(e) Caulking ferrules shall be of approved quality bell shaped cast brass, not less than four inches long and not less than diameter and weight listed in the following table:

Minimum Diameter and Weight of Cast Brass Ferrules.

Diameter (Inches)	Weight (Ounces)
2½	16
3½	28
4½	40

(f) Cleanouts in cast iron hub and spigot pipe shall have brass or iron bodies. Cleanouts shall be the full size of the pipe up to four inches and not less than four inches for larger pipes. The caps shall be of cast brass not less than one quarter inch thick, shall have square or hexagonal nuts not less than three quarter inch high and one and one half inches in least diameter, or recesses for special wrenches, and shall have not less than six tapered threads standard for iron pipe. Caps as described above shall also be used for cleanouts in screw pipe drainage systems.

(g) Where steel or wrought iron pipe, two inches or less in diameter, is connected to cast iron hub and spigot pipe the joint shall be made by means of an approved caulking sleeve or fitting.

(h) Caulking hubs when used on screw pipe shall be heavy pattern. Caulking sleeves shall not be used as hubs.

[**As amended by Ord. 1943, ch. 8*]

†**Sect. 3117. Wrought Iron and Steel Pipe.**— (a) Galvanized wrought iron or galvanized steel pipe shall be of not less than the following thickness and weight per linear foot:—

Size	Diameter (Inches)		Thickness (Inches)	Weight Per Foot (Pounds) Plain Ends
	External	Internal		
⅜	.675	.493	.081	0.567
½	.840	.622	.109	0.850
¾	1.050	.824	.113	1.130
1	1.315	1.049	.133	1.678
1¼	1.660	1.380	.140	2.272
1½	1.900	1.610	.145	2.717
2	2.375	2.067	.154	3.652
2½	2.875	2.469	.203	5.793
3	3.500	3.068	.216	7.575
3½	4.000	3.548	.226	9.109
4	4.500	4.026	.237	10.790
5	5.563	5.047	.258	14.617
6	6.625	6.065	.280	18.974
8	8.625	8.071	.277	24.696
10	10.750	10.136	.307	34.240
12	12.750	12.090	.330	43.775

(b) Nipples when used shall be cut from standard weight pipe.

(c) Fittings for wrought iron or steel soil, waste or drain piping shall be cast iron, recessed and threaded drainage fittings, with smooth interior water-way and threads tapped so as to provide a uniform slope in branches from vertical pipe of not less than one quarter inch per foot. Fittings for wrought iron or steel vent piping shall be cast pattern.

(d) All screw pipe used for soil, waste and vent shall be reamed to eliminate burr.

[†*As amended by Ord. 1943, ch. 8*]

‡**Sect. 3118. Brass, Copper and Lead Pipes.**— (a) Brass and copper pipe for soil, waste and vent pipes shall be of the weight and thickness known in commerce as iron pipe size.

(b) Fittings for brass or copper soil, waste or drain pipes shall be recessed heavy cast brass or cast iron drainage fittings with smooth interior water-way and iron pipe size threads tapped so as to provide a uniform slope in branches from vertical pipes of not less than one quarter inch per foot.

(c) Lead pipes for soil, waste and vent pipes including bends and traps, shall be not less than the following average thickness and weight per linear foot and not more than the following lengths:

Size (Inches)	Thickness (Inches)	Weight per Linear Foot (Pounds)	Maximum Lengths (Feet)
1¼	1/8	2.50	6
1½	1/8	3.00	10
2	1/8	4.00	10
2½	9/64	5.00	10
3	11/64	8.00	4
4	5/32	10.00	4

(d) The use of lead pipes in a drainage system is restricted to the above table. Concealed horizontal lines of lead pipe shall be supported for their entire length. All other lead pipes shall be properly supported to prevent sagging.

(e) Branch connections of lead pipe shall be full size wiped solder joints; connections of lead pipe to cast iron and screw pipe shall be made by means of brass ferrules and soldering nipples respectively to which the lead pipe shall be full size wiped solder joints, other connections in lead pipe shall be made by means of a round or flanged full size wiped solder joint. Overcast or cup joints are prohibited.

(f) Soldering nipples for the connection of lead pipe to screw pipe shall be of approved quality cast brass or of brass pipe, iron pipe size. If cast they shall have not less than the weight listed in the following table:

MINIMUM WEIGHTS OF CAST BRASS SOLDERING NIPPLES.

Diameter (Inches)	Weight (Ounces)
1½	8
2	14
2½	22
3	32
4	56

[‡*As amended by Ord. 1943, ch. 8*]

***Sect. 3119. Hangers and Supports.—Drainage System:** All drain waste and vent piping shall be securely supported with approved metal hangers or supports, in such a manner as to prevent sagging or swaying.

Drainage piping placed in filled ground or other shifting soil shall be securely hung from the building structure by brass rod of approved diameter and rust proof hangers.

Drainage piping placed in filled ground or other shifting soil outside or inside the building structure, shall be properly supported in such manner as to prevent settling of the pipe.

Vertical stacks shall be supported at each floor.

Horizontal lines shall be supported at approximately five feet on centers when of calked lead joint construction and approximately eight feet on centers when of screw pipe construction.

Inserts for concrete construction shall be of malleable iron, cast iron or pressed steel. When pressed steel is used it shall be rust proof and not less than twelve gauge.

Expansion shields when used shall be of an approved type.

Friction clamps when used shall not be made of less than one and one quarter inch by one quarter inch stock.

Three eighth inch rod shall be the minimum size used.

Rod sizes, when used with band or ring type hanger, shall be as follows: piping up to and including two inch in size, three eighth inch, piping two and one half inch and up to and including six inch in size, one half inch piping above six inch in size five eighth inch.

Hangers consisting of rod only shall be in the U form and both ends of the U shall be fastened to the structure, and of sizes called for above.

Water Supply Piping: All water supply piping shall be securely supported with approved metal hangers or supports, in such a manner as to prevent sagging or swaying.

Wire hangers shall not be used for supporting pipes larger than one inch in size. When wire hangers are used the wire shall be not less than one eighth inch gauge.

Horizontal lines of pipe shall be supported as follows: pipes one quarter inch and up to one half inch in size, approximately eight feet on centers and pipes three quarter inch or larger approximately ten feet on centers.

Vertical lines of water supply piping shall be properly supported.

[**As amended by Ord. 1943, ch. 8*]

†**Sect. 3120. Inspection and Tests.**—(a) No part of a plumbing system shall be covered or concealed from view until it has been examined by the plumbing inspector or tested in the presence of a plumbing inspector and approved by the commissioner, who shall examine or test it within two working days after receiving written notice that the work is ready for inspection, weather permitting. No part of a plumbing system shall be used unless the drain, soil, waste, vent and the water supply pipes, when roughed in, have been tested by the plumber in the presence of the plumbing inspector as hereinbefore provided at a time when such test is practicable.

(b) Tests shall be made by water if practicable, or air pressure in such a manner as to disclose all leaks and imperfections in the work.

[†*As amended by Ord. 1943, ch. 8*]

‡**Sect. 3121. Prohibited Fixtures, Fittings and Connections.**— The following list of fixtures, fittings, connections, and devices are hereby prohibited:

Fixtures:	Submerged flushometer closets. Second hand fixtures of objectionable origin, unless approved by the commissioner. Unlined wooden sinks or trays for restaurants and laundries. Long hoppers. Enameled iron water closets and urinals. Wash sinks or basins so fitted as to retain water to be used simultaneously by more than one person.
Fittings:	Double hubs. Sleeves used as hubs. Saddle hubs and bands. Repair clamps.
Connections:	Slip and union joints on sewer side of trap. Drilling or tapping of drain, soil, waste or vent pipes.
Devices:	Traps depending on partitions to form seal. Iron bath traps up to two inch. Water jacketed grease traps. Fire pot hot water generators except on gravity supply hot water systems. Three quarter and full S traps under three inch in size. No trap or water supply piping shall be exposed to freezing without adequate protection.

[‡*As amended by Ord. 1943, ch. 8*]

PART 32.

VALIDITY.

Section 3201. The invalidity of any section or provision of this act shall not invalidate any other section or provision hereof.

PART 33.*

WAR PROVISION.

Section 3301. During the continuance of the existing state of war between the United States and certain foreign countries, and for the period of six months following the termination of such existing state of war, the Building Commissioner may grant a permit allowing the substitution of specified building materials and methods of construction for the materials and methods now required by this code, whenever he shall find that the materials required by the code are not available or cannot be obtained because of a Federal law, rule, or regulation, and that the substitution shall not conflict with the spirit and intent of this code.

[**As inserted by Ord. 1943, ch. 9*]

*PART 34.

FALL-OUT SHELTERS.

Section 3401. Fall-Out Shelters are hereby defined as structures designed and intended to afford reasonable protection against the radio active fall-out from any nuclear explosion when said shelter is beyond the range of destruction of such nuclear explosion. Fall-Out Shelters are not designed or intended to afford protection from blast and radiation effects of the nuclear explosion itself.

Section 3402. The provisions of Parts 2 to 32, inclusive, of this Code shall not apply to Fall-Out Shelters designed for use by 10 or less persons.

Section 3403. Fall-Out Shelters shall equal or exceed the minimum standards prescribed by the National Civil Defense Agency as to size, materials, thickness and strength of materials, floor space requirements per person, ventilation, and protection against radiation.

Section 3404. A Fall-Out Shelter constructed within or abutting an existing structure shall have at least one exit leading directly from the helter to the outside ground surface without passing through the existing structure.

Section 3405. Fall-Out Shelters shall not be converted to other uses unless they comply with the Building Code in its entirety and pertinent zoning regulations in every respect for such use.

[**As amended by Ord. 1961, ch. 5*]

GASFITTING REGULATIONS.

City of Boston Gas Fitting Regulations formulated January 23, 1952, under authority of Chapter 479 of the Acts of 1938 as amended, Section 116 (i), were superseded on February 1, 1961 by the "Massachusetts Code for Installation of Gas Appliances and Gas Piping" established under Chapter 737 of the Acts of 1960.

Section 5. Section one hundred and sixteen of chapter four hundred and seventy-nine of the acts of nineteen hundred and thirty-eight is hereby amended by striking out paragraph (i) and inserting in place thereof the following paragraph: —

(i) The owners of buildings in Boston shall comply with, and all materials used and work performed in gas fitting in Boston shall be in accordance with, the rules and regulations from time to time in effect under the provisions of section twelve H of chapter twenty-five of the General Laws, except as such rules and regulations may be varied under the provisions of sections one hundred and seventeen, one hundred and eighteen and one hundred and nineteen of this code. The commissioner and the health commissioner of the city of Boston shall severally have power to inspect from time to time gas fixtures and appliances in any and all buildings in Boston and to compel compliance in Boston with the rules and regulations aforesaid.

[*Ch. 737, 1960, Sec. 5, Approved Oct. 27, 1960*]

FIRST FIRE ZONE

All that portion of the city which is included within a line beginning at the intersection of the centre lines of Dover and Albany streets, and thence running east through the centre of said Dover street to the harbor commissioners' line; thence by said harbor commissioners' line around the northerly portion of the city to a point on Charles river at the intersection of said line with the easterly line of St. Mary's street extended; thence along said easterly line of St. Mary's street and the boundary line between Brookline and Boston to the centre of Longwood avenue; thence through the centre of said avenue to the centre of St. Alphonsus street; thence through the centre of said street to the centre of Ward street; thence through the centre of said Ward street to the centre of Parker street; thence through the centre of said Parker street to the centre of Ruggles street; thence through the centre of said Ruggles street to the centre of Washington street; thence through the centre of said Washington street to a point opposite the centre of Palmer street; thence through the centre of said Palmer street and through the centre of Eustis street to the centre of Hampden street; and thence through the centre of said Hampden street and the centre of Albany street to the point of beginning.

SECOND FIRE ZONE

All that portion of the city which is included within a line beginning at the intersection of the boundary lines between the City of Boston and the cities of Somerville and Everett; thence by the boundary lines between the City of Boston and the cities of Everett and Chelsea to the intersection with the centre line of Trumbull street extended northerly; thence by said centre line of Trumbull street extended, the centre line of Trumbull street and said centre line extended southerly to the harbor line; thence by said harbor line to its intersection with the easterly line of Pier No. 5, belonging to the Boston and Albany Railroad Company; thence by a straight line across Boston Harbor to its intersection with the harbor line at the easterly corner of Pier No. 1 in South Boston; thence by the harbor line in the northerly, easterly and southerly portions of South Boston to an angle in said harbor line nearly opposite the intersection of the centre line of Columbia road with the centre line of location of the Old Colony Railroad; thence by a straight line to the said intersection; and by the centre lines of Columbia road, Blue Hill avenue, Seaver street, Columbus avenue, Atherton and Mozart streets, Chestnut avenue, Sheridan, Centre and Perkins streets, South Huntington avenue, Castleton street and the centre line of said Castleton street extended to the boundary line between the City of Boston and the town of Brookline; thence by said boundary line to a point therein one hundred feet southwest of Washington street in the Brighton district; thence by a line parallel to

and one hundred feet southwesterly from the centre line of Washington street to an angle formed by the intersection of said line with the extension of a line parallel to and one hundred feet northwesterly of the centre line of Market street; thence by said extension and said line parallel to and one hundred feet northwesterly of the centre line of Market street to a point one hundred feet south of the centre line of Western avenue; thence by a line parallel to and one hundred feet south of the centre line of Western avenue and said line extended to a point in the boundary line between the City of Boston and the town of Watertown south of Watertown Bridge, so called; thence by said boundary line and the boundary lines between the cities of Cambridge and Somerville to the point of beginning, but not including area within the boundaries of the first fire zone.

Also those portions of Hyde Park upon or within one hundred feet of the following named streets and squares: Everett square, so called; Fairmount avenue from River street to the Neponset river; River street from the location of the Boston and Providence Railroad to Winthrop street; Hyde Park avenue on the easterly side from the northerly side of Oak street to Everett street; Hyde Park avenue on the westerly side from the northerly side of Pine street extension, so called, to a point on said Hyde Park avenue opposite the southerly line of Everett street; Harvard avenue from River street to Winthrop street; Maple street from River street to a point one hundred and eighty feet southerly therefrom; Central avenue from River street to Winthrop street; Davison street from Fairmount avenue to a point three hundred feet northeasterly therefrom; Grove street; Pierce street from Fairmount avenue to a point three hundred feet northeasterly therefrom; Knott street from Fairmount avenue to a point three hundred feet easterly therefrom; Railroad avenue from Fairmount avenue to a point three hundred feet northeasterly therefrom; Station street from the Neponset river to a point three hundred feet northeasterly from Fairmount avenue; Walnut street from Fairmount avenue to a point three hundred feet southwesterly therefrom; Maple street from Fairmount avenue to a point one hundred and twenty-five feet westerly therefrom.

[Ord. 1913, ch. 4 and Rev. Ord. 1947, ch. 41, sec. 1]

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